New Card

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Railway Mechanical Engineer

Volume 90 January, 1916 No. 1

Our Change in Name

Attention was directed at length in last month's issue to our new name—*Railway Mechanical Engineer.* As a successor to the *American Engineer,* and the *Railway Age Gazette, Mechanical Edition,* we hope it will find a warm place in your hearts. The change in name does not mean that there will be any change in editorial policy; in fact, practically the same policies will be followed in the effort to develop an even bigger, better and stronger paper.

Steel Freight Car Competition Award

The first prize of $35 in the competition on "Lessons to be Learned From Experience with Steel Freight Cars" has been awarded to Millard F. Cox, assistant superintendent of machinery, Louisville & Nashville, Louisville, Ky. The article appears elsewhere in this issue, as does also an important study on the life of steel freight cars which was presented at the December meeting of the Railway Club of Pittsburgh, by Samuel Lynn, master car builder of the Pittsburgh & Lake Erie. One thing which is made clear in both of these articles is that the problem of repairing and maintaining steel freight cars has proved to be not nearly as serious as was at first anticipated. This was forecast several years ago by the *American Engineer,* and was later demonstrated by studies of steel freight car maintenance which were made on the Baltimore & Ohio (May, 1907, page 157), Pittsburgh & Lake Erie (January, 1908, page 1) and Pennsylvania Railroad (March, 1909, page 81). While special facilities have had to be provided, they have proved to be simple and comparatively inexpensive. Nor has it proved a difficult task to train the men for this special work.

Records of Defects in Equipment

The practice of having reported to the mechanical department defects found in the construction and design of the rolling stock, no matter how small or seemingly insignificant, is important. Reports from the men in the field, such as inspectors and repairmen, as to the troubles they experience with the equipment under their care and, if possible, suggestions as to how these troubles may be overcome, should always be welcomed by the designers of equipment. It may be very small items, such as bolts or rivets that continually fail because they are not large enough, or it may be a more important matter of the frame construction—all should be considered and, being properly recorded, will be of material assistance to the designers when new equipment is to be built or general repairs are to be made. The recording of defects should not necessarily be restricted to the repairmen or the inspectors; the employees all over the line should be in a position materially to assist in this matter. Roads that have followed this practice consistently have been able to so improve their cars and locomotives as to greatly reduce failure, maintenance costs and loss and damage to freight.

Conservation of High Speed Steel

With the increase in price of high speed steel, since the supply of tungsten has been cut off from Germany, it is apparent that anything that can be done to conserve this product will be very much worth while. If the war continues much longer it will not be so much a question of price, but rather whether high speed steel can be obtained or not. Some roads have already made a careful study of the situation and find that by welding on high speed steel tips to lathe tools a considerable saving can be made. In one instance the ends of drills have been slotted out and a piece of high speed steel welded in by the electric welding process. It is of the utmost importance that serious consideration be given the use and disposal of this grade of steel. Should the supply become exhausted it is evident that where it was generally used the speed of the machines will have to be materially reduced, and in this way greatly affect the operation and output of the shop. Those of our readers who have devised special methods for using or of getting more service out of their high speed steel could perform no greater service to their fellow railway men than by publishing the methods they follow. To this end we would be very glad to receive for publication any suggestions regarding the use of this steel, which will tend toward its conservation.

Pitting of Boiler Tubes and Shells

While the pitting of locomotive boiler tubes and shells has always been a source of trouble on a number of roads using bad water, some roads have found recently that the extent to which the pitting takes place has been increasing. Many mechanical department officers look on this trouble as a necessary evil and make the best of it. It is, however, high time that thorough investigations were made with a view of finding a preventive for it. Several roads, believing that it is caused by electrolytic action, have placed zinc plugs in the boiler at the washout plugs, only to find that they disappear in a day's time. On one road 33 lb. of zinc was placed in the boiler in the form of pigs, and it was entirely eaten away in fifteen days. While the experiment was not carried on for a sufficient length of time to ascertain whether the pitting decreased, it would appear that electrolysis had considerable to do with it.

Careful examination of various boilers indicates that the pitting takes place at points of the poorest circulation. It has been noted especially at the bottom of the shell just back of the front tube sheet. On the tubes the pitting seems to be the worst on the under side. That circulation has a good deal to do with it is evidenced by the trouble with the pre-heaters in the Mallet locomotives. In several cases these have had to be removed entirely, as it proved too expensive to maintain the shell and the tubes because of pitting.

Suggestions have come from some of those roads on which pitting is increasing to the effect that, due to the severe treatment received by the interior of the boiler, in order to completely

rid it of scale, the metal becomes more exposed to the ravages of the pitting agent than when a slight amount of scale is allowed to remain on the shell and tubes. Various methods for better protecting the metal have been advanced, such as copper-plating or galvanizing the tubes and painting both the shell and the tubes with a graphite paint, but the results so far have not shown that any of these methods are entirely practical.

Several roads are filling the pits in the tubes with the oxy-acetylene welding process and find that this can be done at a profit, the tubes being placed in service again. Some claim that the life of the tubes can thus be doubled and a material saving made. However, this does not offer any solution to the difficulty as far as it concerns the boiler shell, for it is against the law to do such welding on the shell.

It would appear that this problem is a subject for the chemist to analyze carefully, both from the standpoint of the water used and from the analysis of the steel or iron in the tubes and shells. We shall be glad to hear from anyone who has real live information on this subject.

The Engine Terminal Competition

It has occurred to us that the announcement made on page 604 of the December, 1915, issue regarding the competition on Getting Results from a Big Engine Terminal, may have been misleading. It is not intended to confine the articles to practices in extremely large terminals only; what is meant is the average engine house at the average busy division terminal on any important road. Some of these terminals are better equipped, better manned, and produce better results than others. Our readers want to hear from the foremen of such engine houses as to just what methods they have pursued in obtaining results. There are, however, engine house foremen who have to contend with out-of-date equipment and more than ordinarily curtailed appropriations, and yet these men have their terminals so organized that there is comparatively little friction and locomotives are repaired and returned to service in a minimum time. There are many practices which foremen who are so situated can tell about to the advantage of others all over the country. Furthermore, some of these men, because of the difficulties with which they have to contend, have developed advanced ideas regarding the handling of an up-to-date terminal. We will give a prize of $35 for the best article, judged from a practical standpoint, on the subject of The Handling of a Big Engine Terminal, which is received on or before February 1, 1916. Other articles which may be accepted for publication will be paid for at our regular space rates.

Injector Steam Pipe Failures

In the annual report of the Chief Inspector of Locomotive Boilers to the Interstate Commerce Commission, which appears on another page, attention is called to the fact that accidents due to the failure of injector steam piping have increased during the past year. These failures usually result in injury—sometimes in death—to the occupants of the cab. Many of them occur at the brazing sleeve due to imperfect brazing. The brazing process is strongly intrenched because of its apparently successful use for many years, but it cannot be denied that the quality of the joint produced is uncertain. Two causes for this are mentioned in the report, and the worst phase of the whole matter is the inability to ascertain the condition of the joint by inspection. A remedy for these conditions has been pointed out. It is the so-called mechanical joint which may not only be made with certainty, but may readily be inspected to determine its exact condition. In his report, Mr. McManamy says that "as it is being adopted by many carriers and manufacturers as standard, we have refrained from recommending a rule requiring its use; but unless a reduction in accidents from failure of steam pipes at brazing sleeve can otherwise be brought about, some action in this direction will become necessary." It is surprising that in matters of this kind where personal safety is so obviously at stake, and where it may be insured at a comparatively small expense, compulsion should be necessary to bring about the desired reduction in accidents. To have the matter clearly pointed out should be all that is necessary.

A Competition for Apprentices

For many years this journal has consistently advocated the adoption of modern apprenticeship methods in the mechanical department. The fundamental principles upon which such a system should be based were enunciated by George M. Basford, when he was editor of the *American Engineer,* in a paper which he presented before the American Railway Master Mechanics' Association in 1905. A few years later that association adopted as recommended practice a code of principles to govern apprenticeship, which included the principles that had been advocated by Mr. Basford. Two or three large systems adopted these from the first and made excellent progress in developing strong and effective apprentice systems. Others have adopted them on a smaller scale, either in whole, or in part. As a result much greater opportunities have opened up before young men who wished to enter the mechanical department.

A few months ago we held a competition on "How Can I Help Apprentice Boys?" Few contests have excited more attention, or drawn forth so many contributions. What we should like to do now is to get some light on the other side of the question. From the standpoint of the apprentice what things that have been done for him have proved most inspiring and helpful? How have modern methods or improved practices appealed to the young man? What can be done to make the apprentice course of greater practical value?

We should like to receive a large number of letters on this subject from apprentices, or graduate apprentices who finished their courses after January 1, 1915. We don't expect elaborate essays; we don't care particularly as to whether the spelling and grammar are correct. We want the ideas—the rest can be easily taken care of.

For the best letter on the subject from a practical standpoint, which is not more than 500 words in length and which is received at our office in the Woolworth Building, New York, on or before March 1, 1916, we will give a prize of $15. For the second best article we will give $10. Others which may be accepted for publication will be paid for at our regular rates. Here is a splendid opportunity to convince your superiors that you are using your heads in sizing up the opportunities which are before you, and are thinking of future advancement. While you may be at the bottom of the tall ladder now, your comments or suggestions may be the means of stirring up some railroad officers to give more attention to this important problem and be helpful to many of your brothers throughout the land.

What two young men are going to head the list of the wide-awake, progressive apprentices who are capable of using their heads, and really have some ideas about training and developing of themselves for a big job? What road or what apprentice school will be honored by having the greatest number of entries in the competition?

Systematic Promotion of Men

The greatest incentive for the workmen in the mechanical departments of our railways to leave the ranks of the wage-earners to become foremen is the opportunities they believe they have for advancement. In many cases they make a sacrifice in the matter of income when taking these positions. It is therefore imperative that every road so conduct its mechanical department that the opportunities of the minor officers form a real asset to their position. The foreman or any other officer who sees but little ahead of him cannot be expected to have a whole-hearted interest in his work. He

will be inefficient and the men under him will reflect his inefficiency in their work. Esprit de corps will be lacking.

There are several roads that make a practice of promoting their own men to fill vacancies as they occur. Other roads go outside of their forces for new men to fill these vacancies. A comparison will show that the roads following the former practice are much more efficient. Roads following the latter practice may claim that they have not men competent to fill the vacant positions. This excuse will in almost every case show their ignorance and lack of proper organization. Ignorance—because they do not know what good material they have. Poor organization—because they have not been training their men to fill the vacancies. Every man who holds any kind of office and who desires to progress should be constantly training an understudy. The department, division or shop that will carry on its daily routine in the same efficient manner with the boss away is a sign of good organization and an indication that the person in charge can be promoted without a falling off in the efficiency of his department.

The promotion of men is an extremely important matter. Departments are just as efficient as the men in charge. These men should be chosen with utmost care. The success of the entire organization is dependent on them. Some roads give this matter the consideration it deserves. In the mechanical department on one road in particular it is to be followed in a most scientific manner. Plans are being completed for a system similar to that in effect on the Lake Shore* a few years ago, by which the men available for promotion are to be reported on by their immediate superiors periodically, these reports going to the superintendent of motive power. Ratings on some 20 items are to be made in these reports, each item being a characteristic necessary in a man who is to have responsible charge of men and important work. This provides an excellent record of the available material, insures the choosing of the best men and has a moral effect on the men themselves that is sure to show in the net results of output and efficiency. An organization thus built up will prosper and will have the strongest support of its subordinates.

Electrification and Smoke Investigation in Chicago

The report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals in Chicago brings the discussion of the locomotive smoke nuisance in that city down to a scientific basis, and shows, as was expected, that the air pollution and discomfiture from locomotive smoke is of much less magnitude than popular sentiment has tried to make it. The report, parts of which are abstracted elsewhere in this issue, is of a most thorough, scientific and painstaking nature. It shows that by an expenditure of some $275,000,000 the total smoke in the city of Chicago will be reduced by only five per cent net. Of all the smoke producing services investigated steam locomotives produce 22.06 per cent of the visible smoke in Chicago, ranking third among these services; and, further, inasmuch as it would be impractical to produce electrical energy for the operation of electric trains in Chicago from hydro-electric plants, steam plants would have to be installed, which would reduce the ultimate saving in smoke from locomotives to about five per cent. It is further shown that the electrification of the terminals of Chicago would be the largest undertaking of electrification in the world, and when accomplished Chicago would have a total electrified mileage greater than the present electrified mileage in the world.

While the committee believed that the electrification of the Chicago terminals was technically practical, it stated that from a financial standpoint it was impractical. The heavy expenditure required for electrification, together with the expenditure already required by city ordinances for track elevation, would place a burden on the railways entering Chicago of $5,000 per mile of line owned by these railways. Inasmuch as the laws would not permit the city of Chicago to participate in such an expenditure, it would have to be borne by the commerce of these railways, which if prorated over their entire mileage, would place a severe burden on many people not benefiting by the expenditure, and if this burden were placed on the traffic in Chicago the results would be disastrous to the city.

Regarding the production of smoke by the locomotives in the city of Chicago, the committee called particular attention to the work the railroads have been doing to reduce this to a minimum, and the excellent results that have been obtained. It also included in its report the results of several tests made to determine the amount of smoke, the solids and the gases emitted from the locomotives. Special tests were conducted at the Altoona testing plant of the Pennsylvania Railroad and on locomotives in yard and freight service in the district of Chicago, to determine the amount of solids emitted from the stacks at various rates of combustion. A thorough investigation was also made at the Altoona testing plant of the benefits to be derived from the use of the brick arch in locomotives, both from a fuel and smoke production standpoint. At the same time comparative tests were made with experienced and inexperienced firemen, with the same object in view. In both sets of tests coal from the various parts of Illinois and Indiana was used. Comparisons were also made between Pocahontas and bituminous coal, as regards the emission of solids from the locomotive stacks, and an investigation was made of the distribution of the solids and dust emitted from the locomotives along the right-of-way. The results of all these tests have been included in the abstract in this issue, and the methods of procedure are mentioned in a general way.

* See American Engineer & Railroad Journal, December, 1908, page 453.

NEW BOOKS

Tool Foremen's Proceedings. Edited by Owen D. Kinsey, Secretary. 141 pages. 64 illustrations. 6 in. by 9½ in. Bound in paper. Published by the association, Owen D. Kinsey, secretary, 12323 Princeton avenue, Chicago, Ill.

This book is the report of the seventh annual convention of the American Railway Tool Foremen's Association, which was held in Chicago on July 19, 20 and 21. It contains a paper by B. W. Benedict, of the University of Illinois, on "Getting the Most Out of Tools;" a discussion on special jigs and devices, which is thoroughly illustrated; a discussion on the subject of safety first; the maintenance of pneumatic tools; grinding machine tools; distribution of machine tools; and a report of the Committee on the Standardization of Locomotive Frame Reamers. This subject has been carefully studied by the members of the association, and their recommendations represent standards that could be satisfactorily used to the advantage of both the railroads and the manufacturers.

Mechanical Drawing. By James D. Phillips, professor of drawing, and Herbert D. Orth, instructor in drawing at the University of Wisconsin, Madison, Wis. 283 pages. 295 illustrations. 6 in. by 9 in. Bound in cloth. Published by Scott, Foresman & Co., Chicago, Ill. Price $1.75.

This book is for use in teaching mechanical drawing at universities, and has been arranged to give the student an appreciation of the best commercial drafting room practice while making complete, accurate and well-finished drawings of industrial projects. The book is written for students who may not have had previous experience in drawing. Each element in drawing is treated separately before the elements are combined. The general divisions are introduced in the order in which they would naturally occur in commercial drafting rooms, as follows: Prospective sketching, orthographic sketching, pencil mechanical drawing, tracing and blue printing. The problems in the book have been carefully chosen to illustrate principles of representations, dimensioning, etc., and are arranged in accordance with the principle that the more advanced the position of the problem in the course the more difficult its solution from the standpoint of both the theory and the technique.

TWO POWERFUL 4-6-2 LOCOMOTIVES

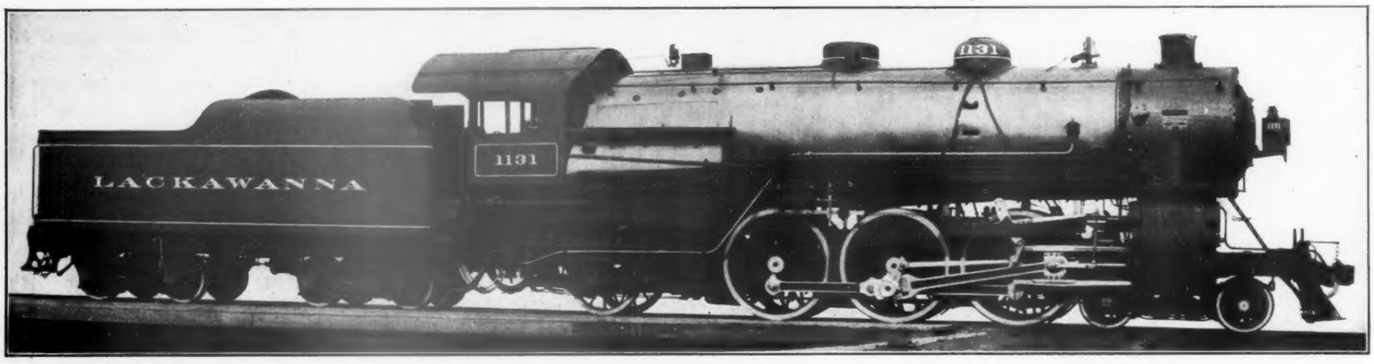
One Class Burns Anthracite, the Other Bituminous Coal; Tractive Effort of Each Exceeds 47,000 Lb.

Two orders of exceptionally powerful Pacific type locomotives have recently been placed in service, one of five locomotives for the Delaware, Lackawanna & Western, built by the American Locomotive Company; the other an order of two locomotives for the Richmond, Fredericksburg & Potomac, built by the Baldwin Locomotive Works. The Lackawanna engines have a tractive effort of 47,500 lb., which is the highest on record for a Pacific type locomotive. The Richmond, Fredericksburg & Potomac locomotives are but slightly less powerful, having a tractive effort of 47,400 lb. A comparison of the principal dimensions of both classes with those of several other large Pacific type locomotives exerting a tractive effort of about 42,000 lb. or over, is given in the table.

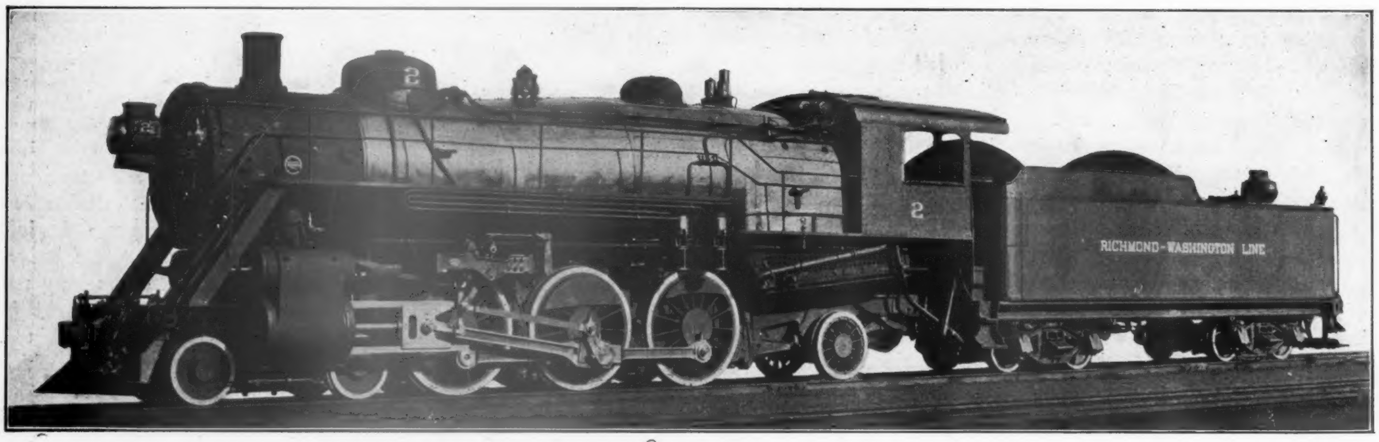
COMPARISON OF RECENT PACIFIC TYPE LOCOMOTIVES EXERTING HIGH TRACTIVE EFFORT

	D. L. & W.	R. F. & P.	C. & O.	C.C. & O.	C. & O.	B. & O.	D. L. & W.	Erie	C. B. & Q.	Penn
Builder	A. L. Co.	Baldwin	A. L. Co.	Baldwin	Baldwin	Baldwin	Lima	Baldwin	Baldwin	Penn
Cylinders, dia. and stroke, in.	27x28	26x28	27x28	25x30	27x28	24x32	25x28	25x28	27x28	27x28
Driving wheels, dia. in.	73	68	69	69	73	74	69	69	74	85
Boiler pressure, lb. per sq. in.	200	200	185	200	185	205	200	200	180	204
Heating surface, evaporating, sq. ft.	3,680	4,205	4,478.8	3,982	3,786	3,936	3,960	3,966	3,364	4035.9
Heating surface, superheater, sq. ft.	760	975	991	955	879	833	740	879	751	1153.0
Grate area, sq. ft.	91.3	66.7	80.3	53.8	59.6	70	69	58	58.7	70
Weight on drivers, lb.	197,300	188,000*	191,000	176,900	179,900	166,200*	184,600	184,300	169,700	200,000
Weight, total engine, lb.	305,500	293,000*	312,600	280,300	282,000	263,800*	297,600	281,600	266,400	305,000
Tractive effort, lb.	47,500	47,400	46,600	46,000	44,000	43,400	43,200	43,200	42,200	41,845

*Weights estimated.



Heavy Pacific Type Locomotive for the Lackawanna

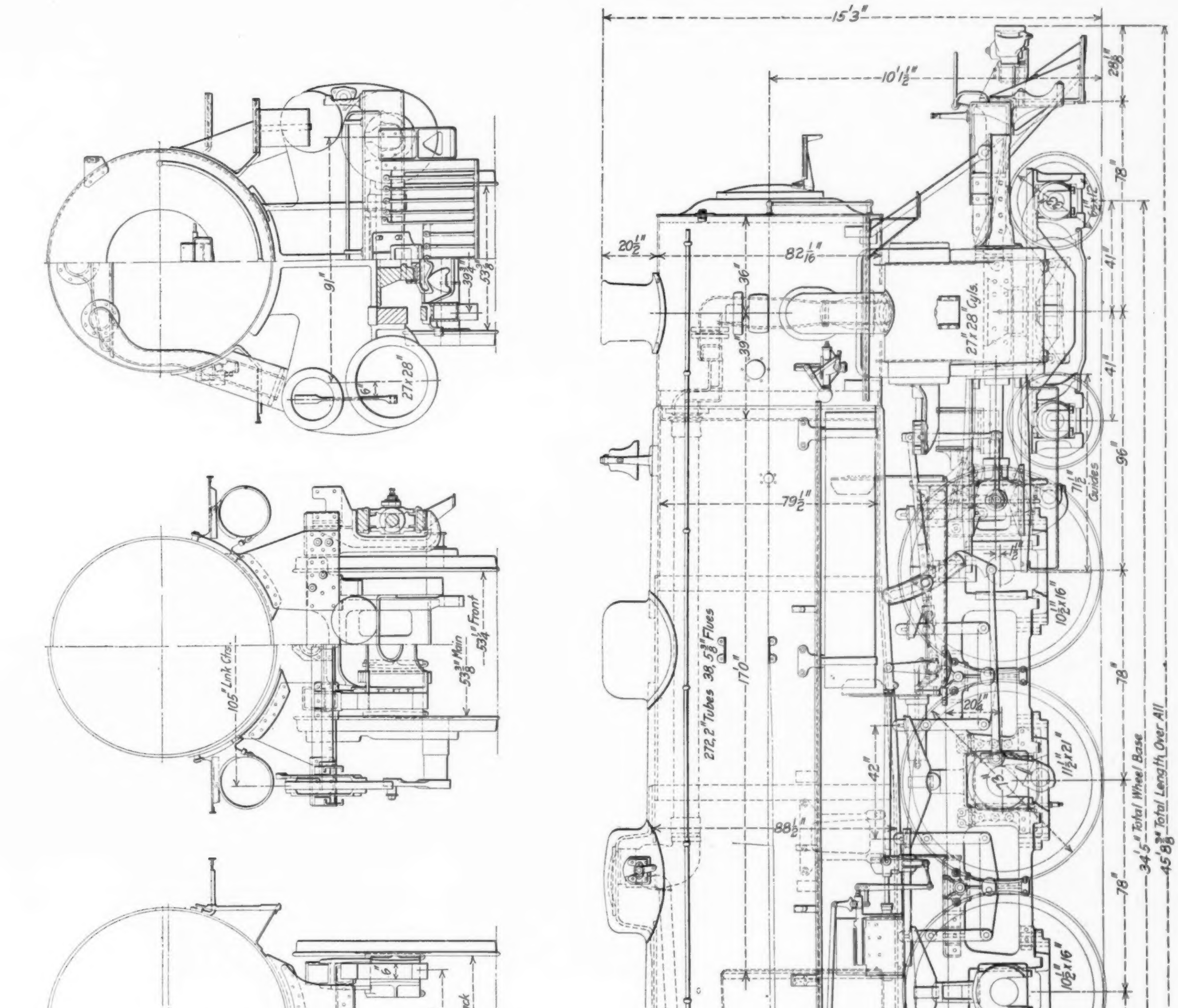


Richmond, Fredericksburg & Potomac Pacific Type Locomotive

THE LACKAWANNA LOCOMOTIVES

The new Lackawanna locomotives are in service between Scranton and Hoboken. This division crosses the Pocono Mountains and has a constant ruling grade between Stroudsburg and Pocono Summit of 78 ft. per mile for a distance of 16 miles, with curves of five and six degrees. About three years ago seven Pacific type locomotives* were built by the American Locomotive Company, to replace a class of heavy 10-wheel locomotives than handling the through passenger service. They were designed to handle a 460-ton train over this grade at a sustained speed of 30 miles an hour and have handled trains of eight cars weighing 530 tons at that speed. The new engines are hauling trains of nine steel cars, weighing 600 tons, under the above conditions. On other trains they are handling from one to two extra cars on schedule time on the grades, and have made it

* For a complete description see the *American Engineer* for August, 1912, page 391.

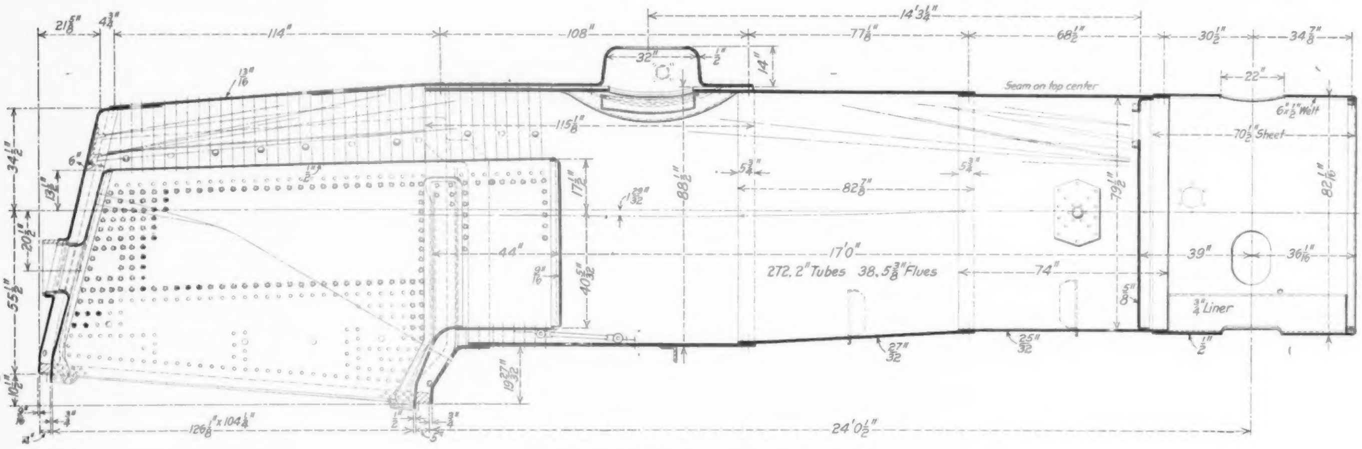


Elevation and Cross Sections of the Lackawanna Pacific Type Locomotive

possible to dispense with all helpers on the mountain district on trains of 10 cars or less.

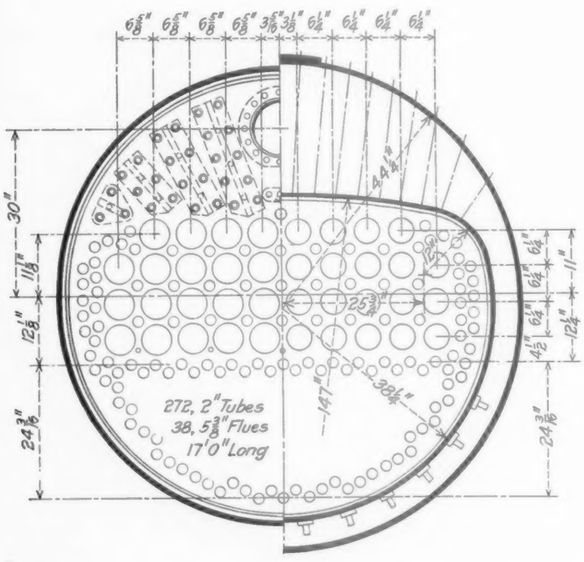
The new locomotives have a total weight, engine and tender, of 471,300 lb., while the Pacifics of the older class have a total weight, engine and tender, of 449,800 lb. and a tractive effort of 40,800 lb. With an increase in weight of 4.8 per cent, an increase in tractive effort of 16.4 per cent has been obtained.

The boiler of the Lackawanna Pacific type has an outside diameter of 79½ in. at the first course, while the diameter of the largest course is 88½ in. Baffle plates are installed along both sides of the dome opening to prevent water from washing into the dome when rounding curves. All longitudinal seams are quintuple riveted. Four of the engines have a total evaporating heating surface of 3,680 sq. ft., while the other, which is provided with a Riegel boiler, has a total of 3,935 sq. ft. of evaporating heating surface.



The Lackawanna Pacific Type Boiler

The firebox is of the Wootten type, for burning anthracite coal, and has a grate area of 91.3 sq. ft. The general design is the same on all five engines, the Riegel firebox differing only in the application of a set of 2½-in. water tubes connecting each side water-leg with the crown. There are 38 of these tubes on each side, with a total heating surface of 260 sq. ft., which, after deducting for the holes in the crown and side sheets, gives a net increase in heating surface of 255 sq. ft. Each firebox includes a combustion chamber 44 in. long.

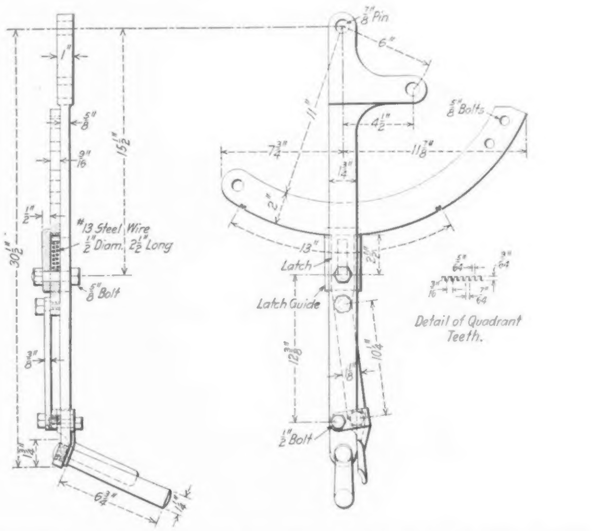


Cross Sections of the Lackawanna Boiler Showing Tube Arrangement

The engines are equipped with the Woodard outside connected throttle*. The throttle rod passes over the outside of the boiler jacket and in through the front of the cab. The throttle lever is arranged to provide a differential leverage. The leverage is greatest and the movement of the end of the lever is largest for a given motion of the throttle rod, when the throttle is closed. After the throttle valve is unseated the leverage increases, with a corresponding decrease in the travel of the lever handle for a given lift of the valve. In this way the travel of the lever handle in the cab may be kept within workable limits and a starting pull obtained sufficient to easily lift the valve.

All driving axles and main crank pins are of Cambria Coffin process steel with 3-in. holes bored the entire length after the completion of the Coffin process. The frames are of vanadium steel.

The special equipment includes Manchester-Riegel by-pass drifting valves, Walschaert direct-drive gear having the combination link attached to the wrist pin, Schmidt superheater, Security brick arch, Ragonet power reverse gear, Foulder solid back end main rod, Woodard inverted link, constant resistance engine truck, Cole long main driving-box, self-centering valve stem guides and radial buffer.

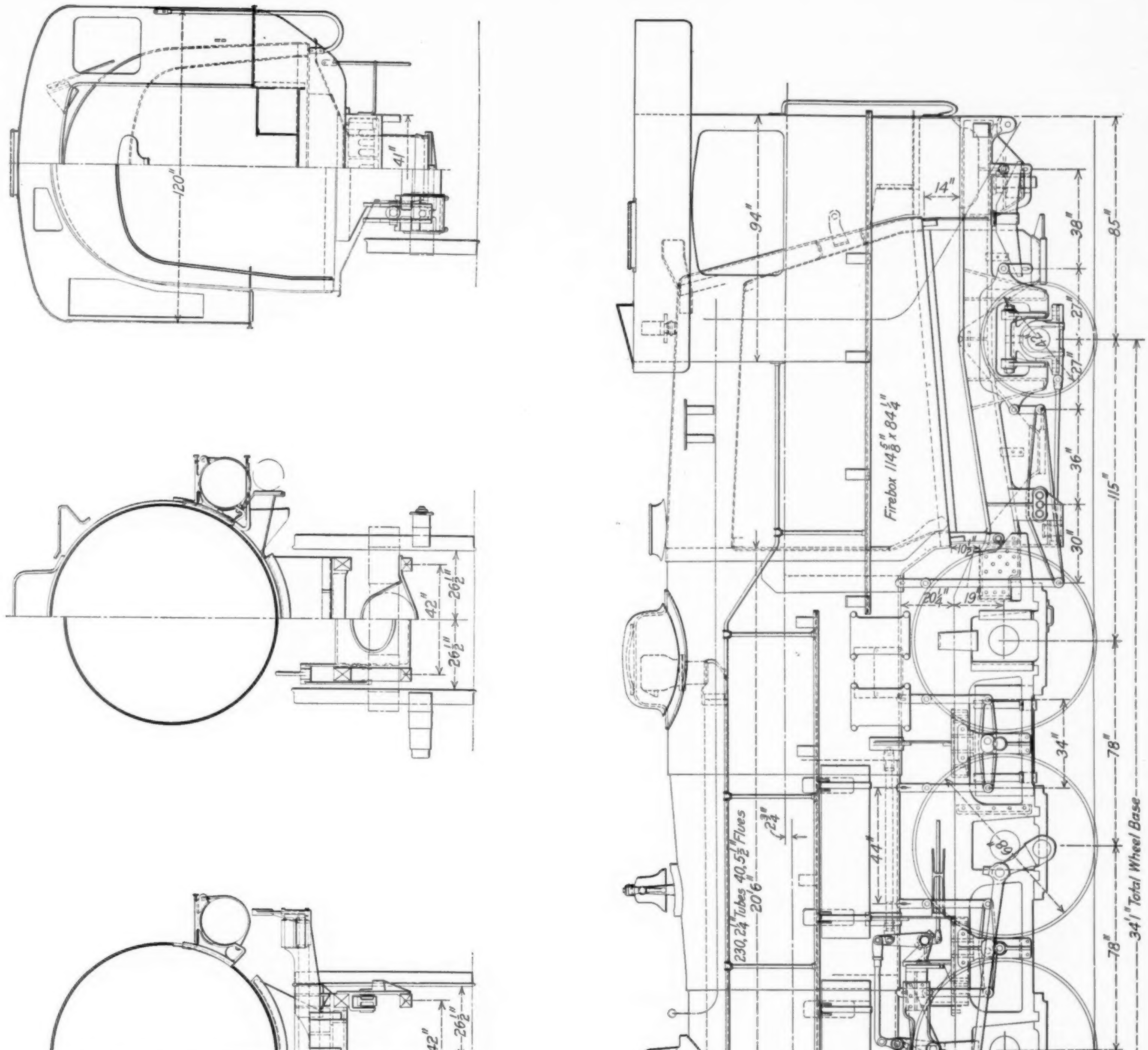


Differential Throttle Lever on the D. L. & W. Locomotives

THE R., F. & P. LOCOMOTIVES

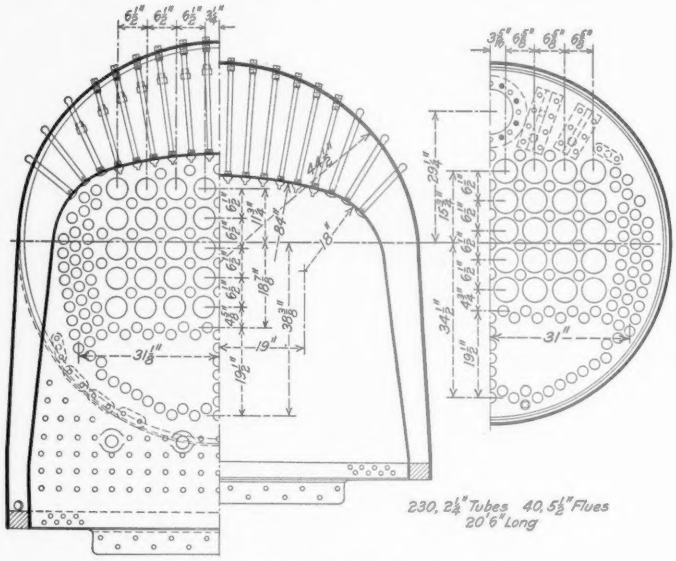
The Richmond, Fredericksburg & Potomac is a double-track line connecting the cities of Washington, D. C., and Richmond, Va. The distance is 116 miles, and besides local traffic, the

*This device is described on page 48 of this issue.



Elevation and Cross Sections of R., F. & P. Pacific Type Locomotive

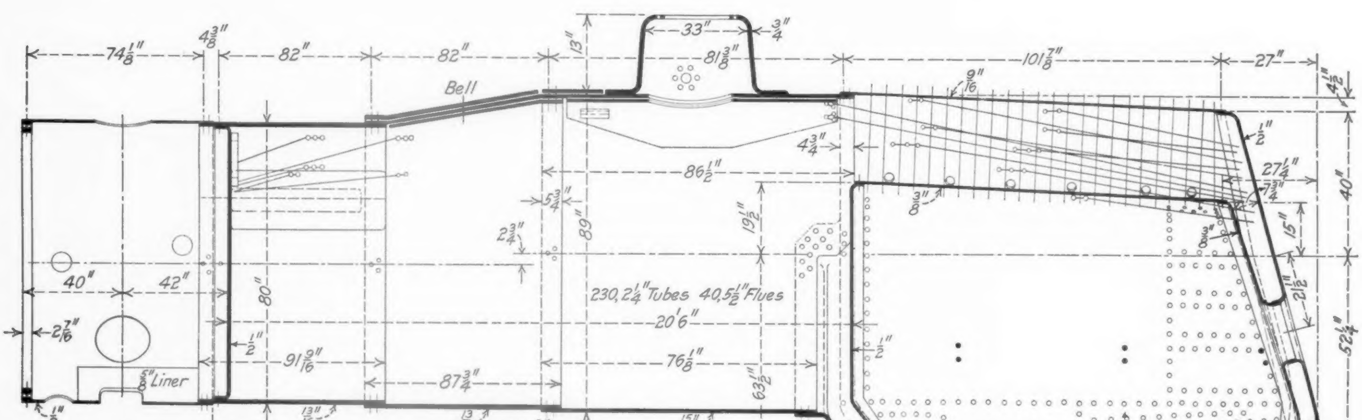
road handles all the through northern connections of the Seaboard Air Line and the Atlantic Coast Line. These trains, especially during the winter tourist season, are frequently very heavy, and are hauled at an average speed, including from two to six stops, of 36 to 42 miles an hour. Including the new engines, four classes of Pacific type locomotives have been built for this service by the Baldwin Locomotive Works. Compared with the first of these, which were built in 1904, the new



Cross Sections of the R., F. & P. Boiler

locomotives show an increase in the tractive effort of 82 per cent.

The boiler is of the extended wagon-top type, measuring 80 in. in outside diameter at the first ring and 89 in. at the dome ring. It is fitted with a one-piece pressed steel dome, measuring 33 in. in diameter by 13 in. in height. The longitudinal seams are welded at the ends and have a strength equal to 90 per cent



Boiler of the Richmond, Fredericksburg & Potomac Locomotive

of the solid plate. A complete installation of flexible stay bolts is used, and the front end of the firebox crown is supported by three rows of Baldwin expansion stays. The firebox is carried on expansion plates at the front and back, and the boiler barrel is supported by waist sheets at three intermediate points. A Security sectional arch, a 40-element Schmidt superheater and a Chambers throttle valve are included in the boiler equipment.

The steam distribution is controlled by "Jack Wilson" piston valves, 14 in. in diameter, driven by the Baker valve gear, and the engines are equipped with the Lewis power reverse gear, furnished by the Compensating Specialties Company, Richmond, Va. Graphite lubricators are applied to the steam chests.

Special material is used quite extensively in the construction of these locomotives. The driving and engine truck axles are of heat-treated steel. Nikrome steel is used for the main and side rods, the crank pins and the cross-head pins, and Hunt-Spiller metal for the cylinder and steam chest bushings, as well as the piston and valve packing rings.

The main frames are of vanadium steel, 5 in. wide, each being cast in one piece with a single front rail, and are spaced transversely 42 in. between centers. The rear frames were furnished by the Commonwealth Steel Company, and are cast in one piece with the back foot-plate, trailing truck pedestals, radius-bar cross-tie and other projections and braces. This constitutes an elaborate casing, with an over-all length of 15 ft. 4¼ in. It has a slab fit in a recess formed in the main frames, and is secured to the latter on each side by 13 horizontal bolts, each 1¼ in. in diameter. Throughout the greater part of its length on each side this casting has a Z-section with walls 12 in. deep and 1½ in. thick. A transverse brace is placed over the rear truck pedestals. The holes for the trailer truck radius-bar pin, equalizing beam pins, etc., are bushed.

The main frames are braced transversely by the guide yoke, valve motion bearer and waist-sheet cross-tie, the latter being a broad casting placed between the main and rear pairs of driving-wheels. The front and main driving pedestals are also transversely braced, the brace at the front pedestal being used as a fulcrum for the driving-brake shaft.

The rear truck is of the Rushton type, with inside journals, In this design the truck swing links are pinned to a pair of yokes which constitute part of the equalization system, the yokes being prevented from moving laterally by the truck pedestals. The pedestals on each side are fitted with renewable wearing plates 3/16 in. thick. There is no cross-connection in the driving equalization system, as the driving and truck journals are in line and the equalizers between the rear drivers and the trailer are connected directly with the spring hangers.

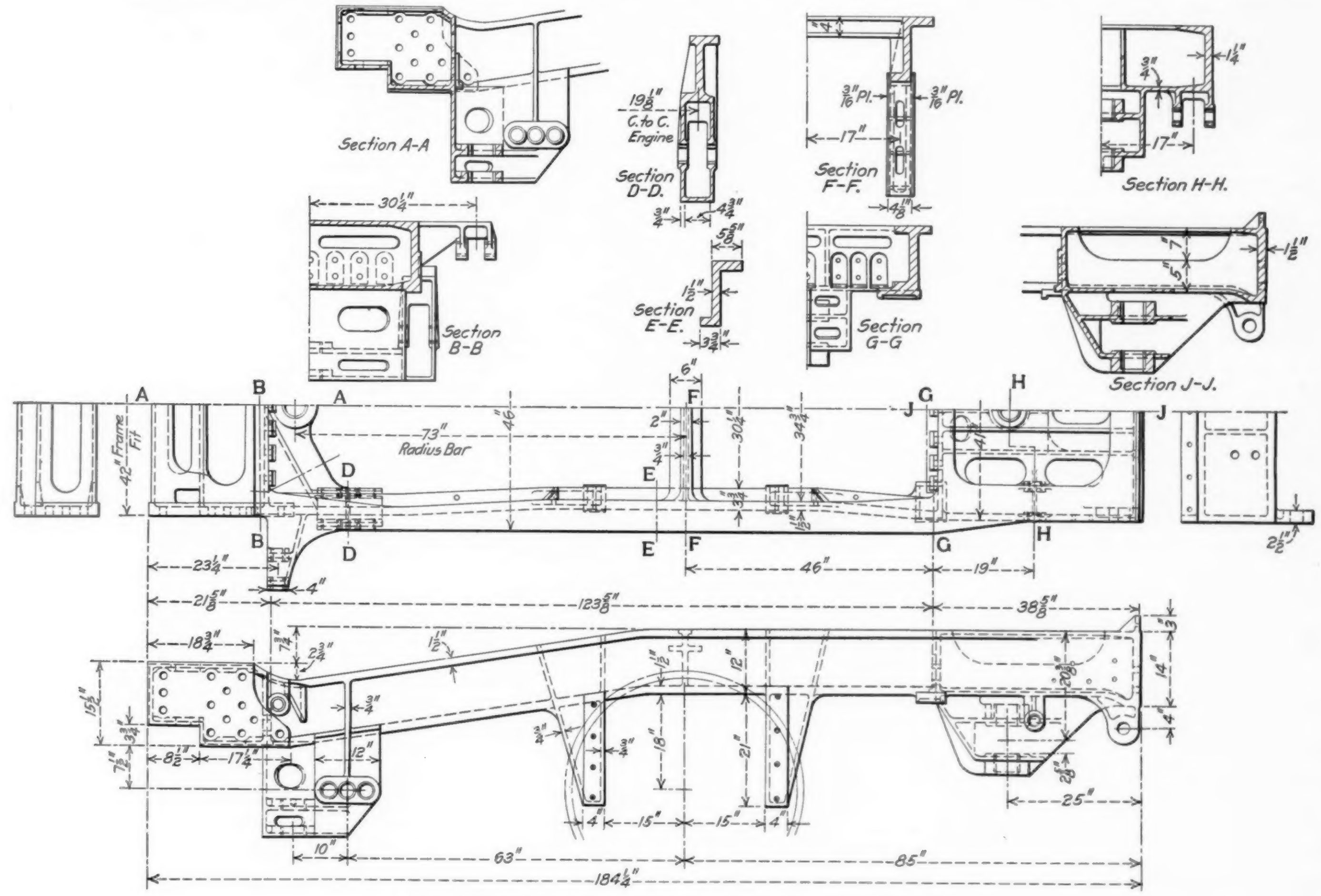
The arrangement of the running-boards and hand-rails is suggestive of the practice followed in certain parts of Continental Europe. The hand rails are placed outside the running-boards, the total width over the latter being 10 ft. 3 in., and a flight of steps leads from the running-boards to the front bumper.

This arrangement adds materially to the convenience and safety of the engine crew.

The principal data and dimensions of both engines are as follows:

General Data

	D., L. & W.	R., F. & P.
Gage	4 ft. 8½ in.	4 ft. 8½ in.
Service	Passenger	Passenger
Fuel	Anthracite coal	Bituminous coal
Tractive effort	47,500 lb.	47,400 lb.
Weight in working order	305,500 lb.	293,000 lb.
Weight on drivers	197,300 lb.	188,000 lb.
Weight on leading truck	52,200 lb.	53,000 lb.
Weight on trailing truck	56,000 lb.	42,000 lb.
Weight of engine and tender in working order	471,300 lb.	472,000 lb.



Cast Steel Rear Frame Unit, R., F. & P. Locomotives

	D., L. & W.	R., F. & P.
Wheelbase, driving	13 ft.	13 ft.
Wheelbase, total	34 ft. 5 in.	34 ft. 1 in.
Wheelbase, engine and tender	67 ft. 1 in.	72 ft. 4 in.

Ratios

Weight on drivers ÷ tractive effort	4.15	3.96
Total weight ÷ tractive effort	6.43	6.18
Tractive effort × diam. drivers ÷ equivalent heating surface*	719.4	569.
Equivalent heating surface* ÷ grate area	52.8	85.0
Firebox heating surface ÷ equivalent heating surface*, per cent	7.7	4.1
Weight of drivers ÷ equivalent heating surface*	40.9	33.2
Total weight ÷ equivalent heating surface*	63.4	51.7
Volume, both cylinders	18.6 cu. ft.	17.2 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	259.8	329.4
Grate area ÷ vol. cylinders	4.9	3.9

Cylinders

Kind	Simple	Simple
Diameter and stroke	27 in. by 28 in.	26 in. by 28 in.

Valves

Kind	Piston	"Jack Wilson" Piston
Diameter	14 in.	14 in.
Greatest travel	6½ in.	
Steam lap	1⅛ in.	
Exhaust clearance	3/16 in.	
Lead in full gear	9/16 in.	

Wheels

Driving, diameter over tires	73 in.	68 in.
Driving journals, main, diameter and length	11½ in. by 21 in.	11½ in. by 13 in.
Driving journals, others, diameter and length	10½ in. by 16 in.	11½ in. by 13 in.
Engine truck wheels, diameter	33 in.	33 in.
Engine truck, journals	6½ in. by 12 in.	6 in. by 10 in.
Trailing truck wheels, diameter	50 in.	42 in.
Trailing truck, journals	9 in. by 15 in.	8½ in. by 14 in.

Boiler

Style	Extended wagon top	Wagon top
Working pressure	200 lb. per sq. in.	200 lb. per sq. in.
Outside diameter, of first ring	79½ in.	80 in.
Firebox, length and width	126⅛ in. by 104¼ in.	114⅝ by 84¼ in.
Firebox plates, thickness; crown and sides, ½ in.; tube, 9/16 in.; back	⅜ in.	⅜ in.; ½ in.
Firebox, water space..front, 5 in.; sides, 5 in.; back, 4 in.		5 in.; 4½ in.; 4½ in.
Tubes, number and outside diameter	272—2 in.	230—2¼ in.
Flues, number and outside diameter	38, 5⅜ in.	40—5½ in.
Tubes and flues, length	17 ft.	20 ft. 6 in.
Heating surface, tubes and flues	3,311 sq. ft.	3,942 sq. ft.
Heating surface, firebox, including arch tubes	369 sq. ft.	263 sq. ft.
Heating surface, total	3,680 sq. ft.	4,205 sq. ft.
Superheater heating surface	760 sq. ft.	975 sq. ft.
Equivalent heating surface*	4,820 sq. ft.	5,667.5 sq. ft.
Grate area	91.3 sq. ft.	66.7 sq. ft.

Tender

Tank	Water bottom	
Frame	Channel	
Weight	165,800 lb.	179,000 lb.
Wheels, diameter	36 in.	33 in.
Journals, diameter and length	6 in. by 11 in.	6 in. by 11 in.
Water capacity	9,000 gal.	10,000 gal.
Coal capacity	10 tons	15 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

FAILURE OF FUSIBLE TIN BOILER PLUGS

An investigation into the failure and deterioration of fusible tin boiler plugs in service has recently been conducted by G. K. Burgess, physicist, and P. D. Mercia, assistant physicist, of the United States Bureau of Standards. In some cases such plugs have failed to melt and so give warning of dangerous boiler conditions, and investigation has shown that the tin filling in these cases had become oxidized, the tin oxide having a melting point above 2,900 deg. F.

One pronounced and dangerous type of deterioration is the oxidation of the tin along the grain boundaries, by which is formed a network of oxide throughout the tin. The plugs showing deterioration of this type all came from the same manufacturer and contained zinc in amounts varying from 0.3 per cent to 4.0 per cent. It was shown that this type of oxidation is due to the presence of the zinc. The latter metal is not soluble in the solid state in tin, and when a tin with small amounts of zinc is heated as in a boiler to about 340 deg. F. the zinc coalesces as a network enveloping the tin crystals or grains. The boiler water, particularly if it contains alkali, will attack the zinc, eating its way into the alloy along the zinc network, and finally form the oxide network described.

Lead and zinc are found to be the principal impurities in tin plug fillings, and since all failed plugs contained these or other impurities the conclusion is reached that if these impurities are eliminated by strict specifications and inspection, which will allow only admittedly superior qualities of tin, the danger of failures of these plugs will no longer exist.

SUGGESTIONS FOR TEAM WORK IN SAVING COAL*

Engineers.—The engineer can burn coal, and burn lots of it. I would ask him to pay strict attention to his fire in order to keep it bright all over the fire box, thus keeping the arch hot and keeping the flues from leaking; to work his engine as economically as he can. If you see that the fireman is getting tired, get down and shake the grates, knock over any banks and brighten up the fire to help get her hot, and if you can, dump the ash pan. And do not let the tank run over; just take enough to fill it properly. Get up on the tank and shovel over some to help get it in. I do this almost every trip. Try to get away from the water plugs as soon as the fireman is through taking water. To have the fire ready for the quick movement of a train means the saving of fuel. Drop down every time you stop and see that your sand pipes are open and working and you will save many a shovel of coal on a hard pull. Get your engine into the yard and on the ash-pit as soon as you can, thus shortening the hours and saving coal.

Firemen.—I don't want to ask the firemen to do too much, but I know they can save coal if they try. First of all, keep your decks clean, as the coal falls through to the ground and many a shovelful is lost. Keep the coal back from the corners of the tank as much as you can. Fire the engine with as bright a fire as it will stand; fire light and often; keep the fire shook down, as an engine will not steam with combustion from the fire door. Watch the water in the boiler when the engineer is away. Don't let the engine pop—put in more water to help you get your fire up when the engine starts. Keep a bright fire up under the arch or under the flue sheet, for this keeps the flues from leaking and will save lots of coal.

Brakemen.—I want to ask the brakeman to take a wrench with him when he starts to couple up the hose. After he has gone back as far as he intends to and starts back over the train toward the engine the air will then be in the train pipe, and if he finds a small leak around a union or joint he can tighten it up, and if in a coupling, he can give it a tap and try to stop the leak, for leaks keep the pumps running hard all the time, and it takes steam to run them and it takes coal to make steam. If he finds a brake not released, see if a retainer handle is not up, and let it down and let off all hand brakes and see that the shoes are loose. If he does this, when he gets to the engine, he will have helped to save coal.

Conductors.—I want to ask the conductor to help also. Every time that a train is stopped or an engine detached from a train at a coal tipple or water plug, make an effort to get over to the head end or as near as you can, and as the train pulls by bleed off any stuck brakes. If you just release one brake you will save many a shovelful of coal.

Round House Foremen.—I would like to see a man instructed to pay strict attention to the sanding arrangement, to see that the sand in the box is in proper condition and that the air is open from the sand-valve to the trap. I have taken pipes off and found them stopped up with rust and no air going into the trap. He should also see that the pipes are tightly clamped and in place; I have opened pipes and put them in place and the next time I stopped found them turned around out of place by the pound in side rods, the sand being blown out on the ties. If this man finds anything which causes the pipes or traps to get wet, such as branch pipes or boiler checks leaking, let him see that the leaks are stopped.

Fire-Up Men.—I have sat on an engine and watched the fire builder shovel coal into an engine to cover the grates, and I know that half he threw into it fell into the ash-pan and after a while was dumped over the bank. Now if he would make an effort to get down coarse coal to cover the grates and not throw in any slack until he has a fire burning, he would be the means of saving a lot of coal. I have gotten engines out with a foot and a half of unburned coal in the firebox, caused by the men crowding the fire to get the engine hot. These men could be taught to save a great deal of coal.

Hostlers.—I would ask them to be careful in filling tanks, to place the coal in the proper place and to take just enough to fill the tanks. The coal which falls down in the deck should be thrown back to keep coal from under the men's feet so it will not be kicked off. A machinist, fire knocker, or any other man who has to get on the engine likes to have a clean place to stand on.

Car Inspectors.—The car inspector comes in for his part in saving coal. If he will take a special interest in replacing any badly worn gaskets or hose and in tightening old unions, or will hold a train a few minutes while he does this work (he has the tools to do so while men out on the road have not) and put on release rods where missing, he will save many a delay on the road. I was recently on the head end of a train when a gasket in a union under the head car blew out; the union was in a bad place—probably was leaking when we started out—and the jar and working of the car caused the gasket to blow out and stopped the train. We were delayed twenty-five minutes while this was located. As nothing could be done with it, the helper held up the air from the rear until we could reach a point where the car could be set out. Please notice that two engines were burning coal during this delay.

Operators.—They can help by keeping a close watch on the movement of all trains and reporting to the despatcher the approach of a train, so that orders can be gotten ready and arrangements made to keep that train in motion. I stopped at a telegraph office not long ago with orders laying on the table, and no light out, waiting on the block for fifty minutes before finding out what was delaying us. Just consider the amount of coal that was burned in that time by two engines. If only the operator had put a light out this would have been saved.

Yard Masters.—The yardmaster can help by having trains ready before asking for engines and having them in a place so that the crews can get to them and get out of the yard in as short a time as possible. Upon arriving at a terminal he can help us get rid of the cars and get the engines to the ash-pit without delay.

* Part of an address by W. E. Brewer, locomotive engineer, before a Baltimore & Ohio employees' meeting.

Smoke and Electrification in Chicago

Abstract of Report of Association of Commerce With Results of Some of the Special Investigations

The complete electrification of the Chicago railroad terminals as a means of abating smoke is technically practical, but financially impracticable. This is the finding of the Chicago Association of Commerce Committee of Investigation on Smoke-Abatement and Electrification of Railway Terminals, which has been studying the problem since early in 1911. The committee, in addition, holds that the elimination of steam locomotives alone would produce a hardly perceptible betterment of the Chicago atmosphere, and urges the appointment of a permanent Municipal Pure Air Commission which both through instruction and coercion shall reduce all sources of air pollution to a minimum.

The association committee, as a result of its painstaking investigations, reaches the following conclusions:

That the minimum cost of electrification as means in smoke-abatement would be	$178,127,230
That the more probable cost, due to the necessity for improvement and rearrangements, which would be precipitated by electrification, would be	274,440,630
That the least net annual operating deficit produced by electrification would be	14,609,743

That the Chicago electrification would equal the combined electrifications of the whole world, would involve problems never heretofore met, and would be the first ever undertaken for air betterment where terminals were adequate from an operating viewpoint.

That the steam locomotive stands third among smoke-producing services, using but 12 per cent of the fuel consumed, and that its elimination would reduce the gaseous pollution of the air only 5 per cent and the solid pollution less than 4 per cent.

That electrification, hydro-electric and other long-distance transmission being inapplicable, would add power-house smoke in quantities sufficient to offset much of the gain through elimination of locomotive smoke.

That suburban passenger services, such as those of the Illinois Central and other roads, produce but 1.54 per cent of the total visible smoke, and 1.97 per cent of all the dust and cinders.

That electrification would involve at least 3,476.4 miles of track.

That electrification would subtract only 1,291,282 tons of coal from the total of 21,208,886 tons now consumed annually in the city.

That, despite the fact that Chicago burns more coal annually than any other large city—eight tons per capita as against four for Manchester and one and one-half for Berlin—its air is better than that of most large cities.

That, in Chicago air, the products of combustion constitute only two-thirds the total pollution, the other third being due to avoidable and unavoidable dirt from the general activities of the city and from poor municipal housekeeping.

As regards the financial practicability of electrification the committee submits these findings:

"The complete electrification of the railroad terminals of Chicago as a betterment to be brought about by the railroads through the investment of free capital is, under present-day conditions, financially impracticable."

Notwithstanding the engineering difficulties that would have to be overcome in electrifying the terminals, the committee believes that these difficulties can be surmounted. Its work leads it to the conclusion that the only feasible means of electrification will be the overhead contact system or trolley. Great obstacles exist to the installation of any system, but it is believed the trolley wire more nearly meets all demands than the third rail.

Electrification and Its Cost

Thirty-eight steam railroads would be involved in the Chicago project. Twenty-five maintain passenger and freight service and 23 are classed as trunk lines, while 13 perform transfer or switching service only. It was found that the Chicago mileage would be nearly twice that of all other electrically operated mileage in America, and, exclusive of foreign light-service lines, would be about 15 per cent greater than all existing electrifications in the world. Of switching service, which constitutes 59 per cent of the total locomotive mileage and presents a grave problem in that it has never been attempted electrically on a large scale, it has been ascertained that yard freight-switching services, on the basis of car-miles, is more than 65 times as great as that on all existing electrified steam roads in America.

In arriving at the cost of electrification, the committee based its work on 1912 operation, extended to meet conditions if electrification were to begin in 1916 and be completed in 1922. The following accounting statement shows why the committee holds that electrification is financially impossible. The deficit on the minimum outlay of $178,127,230 would be too great:

I. Annual Charges:		
1. Interest	$8,906,362	
2. Depreciation	7,808,278	
3. Replacement of dissipated assets	231,796	
4. Indeterminate charges		
Total charges		$16,946,436
II. Annual Revenues:		
1. Increase in net revenues	$2,336,693	
2. Indeterminate benefits		
Total credits		$2,336,693
Balance, annual deficit on investment		$14,609,743

The investigations show that electrified operation for all the railroads taken together and disregarding depreciation and interest would result in a decrease in operating expenses. Under steam operation those accounts that would be affected one way or the other by electrification show a total of $10,934,064. Under operation by the 600-volt direct-current third-rail system the total would be $8,442,298, with the 2,400-volt direct-current system it would be $7,355,771 and with the 11,000-volt alternating-current system it would be $7,140,495. The installation of these three systems would result in a saving in operating expenses respectively of $2,491,766, $3,578,293 and $3,793,569.

This saving, however, is in part nullified by new expenses due to the operation of stations that would have to be established at the end of electrified tracks to provide for a transfer of trains from electric to steam locomotives, and also by the waste and consequent loss due to operating over shortened steam railroad divisions, which have surrendered part of their mileage to make the new terminal electric divisions.

Air Pollution

As a result of its investigation into air pollution the committee finds that one-third comes from sources other than combustion. The air is filled with vegetable, animal and mineral matter which rises from the various activities of the city. Table I shows the standing of the various services investigated as to air pollution.

Table I.—Responsibility of Each Service for Smoke Pollution Within Chicago, on Percentage Basis

	Visible smoke per cent	Solids of smoke per cent	Total of smoke per cent	Gaseous carbon per cent	Gaseous sulphur per cent
Steam locomotives	22.06	7.47	10.31	10.11	18.22
Steam vessels	0.74	0.33	0.60	0.55	0.45
High pressure steam stationary power and heating plants	44.49	19.34	44.96	40.68	53.70
Low pressure steam and other stationary heating plants	3.93	8.60	23.00	23.06	19.73
Gas and coke plants	0.15				
Furnaces for metallurgical, manufacturing and other processes	28.63	64.26	21.13	25.60	7.90

One-third of all air pollution is due to dirt other than that of combustion. These percentages refer to the remaining two-thirds.

In its study of air pollution the committee states that even the comparatively small reduction to be expected from electrification is made less significant when it is recollected that substantial progress in recent years has been made in reducing the smoke from locomotives in Chicago. There is every reason to

believe also that the process has not yet reached its maximum. The improvement has resulted both from embellishments in locomotive design and from the exercise of greater skill in operation. The report states:

"Among the more important changes in design which have aided in smoke abatement are the enlargement of grates, which has resulted in lower rates of combustion per unit area of grate, and consequently in a reduction in the amount of solids in locomotive smoke; the adoption of the brick arch in locomotive fire-boxes, by means of which a reduction in the amount both of visible smoke and of the solid constituents of smoke has been effected; the more efficient design of draft appliances, by which the air currents stimulating the fire have been modified and smoke production diminished; the introduction of superheaters, whereby the efficiency of the locomotive as a whole has been increased, the amount of fuel required for the performance of a given service diminished and the volume of smoke diminished; and the introduction of steam jets and other appliances especially designed to diminish visible smoke.

"Meanwhile, the amount of smoke emitted within the city has been greatly reduced through the exercise of diligence and skill in the operation of locomotives. The importance given this aspect of the matter by the railroads of Chicago is to be seen in the number of smoke inspectors which they have employed."

TABLE II—CONTRIBUTIONS MADE BY STEAM LOCOMOTIVES TO THE POLLUTION OF THE ATMOSPHERE OF CHICAGO

Service	Fuel consumption per cent	Visible smoking per cent	Solids in smoke per cent	Gases in smoke per cent
Yard	5.97	10.25	1.73	5.17
Road freight	0.77	2.01	1.18	0.66
Freight transfer	2.02	4.59	0.43	1.74
Passenger transfer	0.12	0.19	0.04	0.10
Through passenger	1.01	2.07	1.80	0.89
Suburban passenger	0.88	1.54	1.97	0.74
Locomotive terminals	1.17	1.41	0.32	1.01
All other classes of smoke producers	88.06	77.94	92.53	89.69

Table II gives the relative information concerning the importance of the various classes of steam locomotives as a source of smoke.

METHOD OF MEASURING SMOKE

In the committee's investigation in determining the relative density or visibility of the smoke the Ringelmann method was employed. In computing the smoke density for a number of stacks or for those of an entire service or district the observed results are reduced to unit values, the value of one stack for a period of one minute being termed a "stack minute," and the emission of No. 1 smoke for one minute, or its equivalent, being termed a "smoke unit." By employing these unit values the percentage of density as measured by the Ringelmann scale may be computed by means of the following formula:

$$\text{Percentage density} = \frac{\text{Smoke unit} \times 20}{\text{Stack minutes}}$$

In the development of the committee's investigation with reference to the visible properties of smoke a corps of from 16 to 20 trained smoke inspectors under the supervision of a chief inspector were engaged in making observations of smoke density from April 22, 1912, to March 14, 1913. Observations of smoke from locomotive smoke stacks were made at each railroad yard, at each locomotive terminal, and at various points along each line of railroad within the area of investigation. This area extends to include Evanston, Ill., on the north, to Gary, Ind., on the south, the western boundary passing through Harvey, Blue Island and La Grange, Ill. The whole area was divided into two zones, *A* and *B*, the former including the city of Chicago and the latter the territory outside the city limits. The records show that 10,653 observations were made of smoke emissions from steam locomotives in railroad yards and at points on the line, and that 1,323 observations were made of smoke emissions from locomotives at terminals, a total of 11,976 observations. It was found that more smoke was produced, or rather, the average density of the smoke was greater, in the outer zone, Zone *B*, than in the inner zone, the latter including the most congested part of the area of investigation. The average density for Zone *A* was 15.30 and for Zone *B*, 23.17, making an average of 16.79. The road freight locomotives gave the greatest trouble, the average density in Zone *A* for this class of locomotive service being 25.32, and in Zone *B*, 26.91.

SOLID CONSTITUENTS OF STEAM LOCOMOTIVE SMOKE

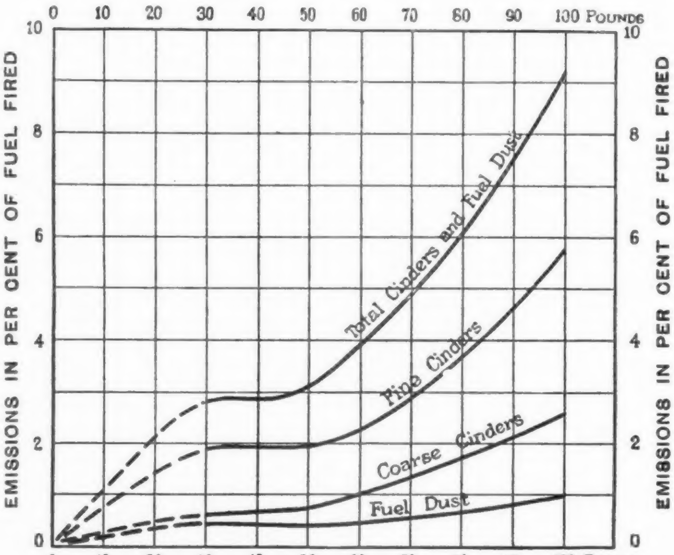
Information concerning the solid constituents of locomotive smoke has been derived from two series of investigations made by the committee in which the solids discharged from the smoke stack were measured. These embrace service tests conducted in connection with locomotives operating in yard and transfer service within the area of investigation, and laboratory tests conducted in connection with a locomotive mounted on a testing plant and supplemented by tests on locomotives operating in through passenger, through freight and suburban services in the area of investigation, to determine rates of combustion. By means of special apparatus all or a known portion of the solid emissions from the smoke stack were caught and deposited in an arrester from which they could be collected for analysis. The samples were classified as follows:

Coarse Cinders—Solid particles which remain upon a coarse sieve of 20 meshes to the inch (400 apertures per square inch).

Fine Cinders—Solid particles which pass through the coarse sieve and remain upon a fine sieve of 200 meshes to the inch (40,000 apertures to the square inch).

Fuel Dust—Solid particles which pass through the fine sieve.

The road tests were conducted with suitable apparatus for obtaining a known proportion of the cinders emitted from the stack.



Amount of Solid Constituents of Smoke Emitted by a Locomotive on a Testing Plant

A record of the number of scoops of coal fired was taken, the average weight of a scoopful of coal being ascertained by experiment, and with this information the relation between the solid constituents of locomotive smoke and the fuel consumed was established. Forty-one tests were conducted on steam locomotives operating in yard and transfer services of Chicago terminals. Bituminous coal was used for some of these tests and Pocahontas coal for others.

Since any method which could be satisfactorily applied in service was found impracticable for determining the amount of solid matter contained in smoke arising from locomotives while operating at high speed, data relating to the amount of solids emitted in smoke at various rates of combustion was secured

by means of a series of tests conducted at the locomotive testing laboratory of the Pennsylvania Railroad at Altoona. The locomotive used in all laboratory tests was a Consolidation freight locomotive of the Pennsylvania type H-8-B, weighing 238,300 lb The coal for the test was typical of that used by the railroads entering Chicago. The locomotive firebox was equipped with a brick arch and all tests were conducted with the throttle fully open, the speed being controlled by the load. A total of 76 tests were made. The maximum rate of combustion for each sample of fuel tested was more than 80 lb. per square foot of grate surface per hour, and in all except two cases was more than 100 lb. per square foot of grate surface per hour. The minimum rate of combustion for the several coals varied from 23 to 27 lb per square foot of grate surface per hour. The accompanying diagram shows the percentage of the fuel burned which appears as solids in the smoke as averaged from all the tests made. It is shown by this diagram that the amount of solids emitted in smoke is a function of the rate of combustion. To establish these rates of combustion attending the normal operation of locomotives in through and suburban services in Chicago a series of 298 tests was made on locomotives operating within the area of investigation. The rate of fuel consumption was found by counting the scoops of coal fired, the value of the average scoopful having been carefully determined. The grate area of each locomotive was obtained from the railroad and all the rates of combustion determined. These were found to be for the several services involved, as follows:

Service	Lb. per sq. ft. grate surface per hour	Per cent of fuel fired while running
Road freight	40.6	92.7
Through passenger	52.2	98.2
Suburban passenger	62.7	96.4

By combining these rates of combustion with the values for the emission of cinders as set forth in the diagram, and by mul-
while running, the emission factors for solids emitted by locomo-
tiplying the values ascertained by the percentage of fuel fired
tives operating within the area of investigation were established.

PERFORMANCE OF ILLINOIS AND INDIANA COAL

The following is a more detailed description of the test made by the committee on the Consolidation locomotive at the testing plant of the Pennsylvania Railroad at Altoona. The tests were planned for the prime purpose of establishing facts with reference to the smoke discharges of steam locomotives, and to show also the value of the brick arch in the locomotive firebox as a factor promoting economy in the use of fuel, a reduction of cinders and fuel dust in smoke, a reduction of the density of visible smoke, reduction of loss of heat units in smoke and ash discharges, and boiler efficiency. The value of experience in locomotive firing as a factor in promoting economy of fuel consumption, a reduction of cinders and fuel dust in smoke, a reduction in the density of visible smoke and in boiler efficiency was also considered.

TABLE IV.—AVERAGE AMOUNT OF EACH CLASS OF SOLIDS DEPOSITED IN PANS, PER CENT

Pan	Distance	Place	Zone	Per Cent Cinders from locomotives: Coarse	Fine	Dust	Matter not from locomot'es
1	20 ft.	Yards	A	58.03	34.40	2.98	4.59
			B	19.86	22.85	12.12	45.17
		Main line	A	57.55	24.68	4.51	13.26
			B	54.62	25.25	1.82	18.31
2	40 ft.	Yards	A	57.16	35.75	2.60	4.49
			B	43.66	22.25	9.99	24.10
		Main line	A	62.63	26.91	4.35	6.11
			B	56.02	28.25	1.86	13.87
3	60 ft.	Yards	A	62.84	30.88	2.16	4.12
			B	54.98	22.30	6.46	16.26
		Main line	A	58.54	28.06	5.50	7.90
			B	59.11	26.23	1.92	12.74
4	80 ft.	Yards	A	65.08	29.19	2.11	3.62
			B	56.86	29.04	2.95	11.15
		Main line	A	54.24	36.27	5.08	4.41
			B	52.02	32.28	2.93	12.77
5	100 ft.	Yards	A	62.10	27.69	3.16	7.05
			B	51.05	28.20	2.47	18.28
		Main line	A	47.54	36.56	7.26	8.64
			B	34.63	24.04	9.93	31.40
6	125 ft.	Yards	A	45.41	34.14	4.20	6.25
			B	9.81	11.65	3.91	74.63
		Main line	A	43.00	38.71	8.32	9.97
			B	33.15	31.59	17.30	17.96
7	150 ft.	Yards	A	52.77	37.49	3.66	6.08
			B	21.38	23.70	7.57	17.35
		Main line	A	42.37	36.65	8.55	12.43
			B	35.11	34.80	5.56	24.53
8	200 ft.	Yards	A	35.53	46.54	6.02	11.91
			B	12.29	24.81	14.78	48.12
		Main line	A	39.90	28.61	8.28	20.11
			B	26.74	36.76	7.84	28.66
9	250 ft.	Yards	A	21.34	37.28	13.08	28.30
			B	19.11	22.44	7.14	51.31
		Main line	A	30.97	33.98	9.84	25.21
			B	10.81	20.07	3.89	65.23
10	350 ft.	Yards	A	30.76	47.77	9.56	11.91
			B	9.82	22.73	11.15	56.30
		Main line	A	20.92	32.66	12.40	34.02
			B	14.34	27.57	6.13	51.96

TABLE III.—EMISSION FACTORS FOR SOLID CONSTITUENTS OF STEAM LOCOMOTIVE SMOKE

Service	Kind of fuel	Solids in lb. per ton of fuel burned: Coarse	Fine	Dust	Total	Solids in per cent of fuel burned: Coarse	Fine	Dust	Total
Yard	Pocahontas	1.30	9.72	24.54	35.56	0.065	0.486	1.227	1.778
Yard	Bituminous	0.76	3.42	5.24	9.42	0.038	0.171	0.262	0.471
Road freight	Bituminous	11.30	34.68	6.86	52.84	0.565	1.734	0.343	2.642
Freight transfer	Pocahontas	1.84	7.92	19.64	29.40	0.082	0.396	0.982	1.470
Freight transfer	Bituminous	0.62	2.16	4.46	7.24	0.031	0.108	0.223	0.362
Passenger transfer	Pocahontas	1.30	9.72	24.54	35.56	0.065	0.486	1.227	1.778
Passenger transfer	Bituminous	0.76	3.42	5.24	9.42	0.038	0.171	0.262	0.471
Through passenger	Pocahontas and bituminous	15.08	39.40	7.84	62.32	0.754	1.970	0.392	3.116
Suburban passenger	Bituminous	20.54	47.42	9.26	77.32	1.032	2.371	0.463	3.866

The emisson factors for solid constituents of locomotive smoke thus determined, and also those for yard and passenger service, as determined by use of the cinder arrester in service tests, are presented in Table III.

SPREAD OF SOLID MATERIALS IN THE SMOKE OF LOCOMOTIVES

For the purpose of ascertaining the facts concerning the physical properties of particles emitted, and the distance traversed by them, an extensive series of tests was undertaken and conducted by the committee. These tests were conducted throughout the two zones of investigation, both in the switching yards and on the main lines of the railroad. Of the total number 64 were conducted in Zone *A* and 36 in Zone *B*. A series of 10 galvanized iron pans, each 18 in. square and 6 in. deep, constituting an open receptacle with an area of 2.25 sq. ft., were placed at definite distances on the lee side of the track. The average duration of each test was 5.5 hours. The total amount of the cinders caught were computed, and further divided as coarse and fine cinders, fuel dust, inorganic matter and organic matter, the last two being deposited in the pans due to the suction created by the train and not from the locomotive. The average amount of each which were deposited in each pan is shown in Table IV.

A total of 75 tests were made, in 56 of which the locomotive firebox was equipped with a brick arch and in 19 the arch was removed. Sixty-four tests were made with experienced firemen and 11 were made with inexperienced firemen. The coals selected for this series of tests were representative of the coals burned in locomotives operating in the Chicago terminals. Coals were obtained from the following 10 counties: Macoupin, Ill.; Marion, Ill.; Saline, Ill.; Sangamon, Ill.; Vermilion, Ill.; Williamson, Ill.; Greene, Ind.; Sullivan, Ind.; Vermilion, Ind., and Vigo, Ind. The coal from Saline, Ill., has an average heat value of 13,247 B.t.u., while the other nine varied between 11,227 and 11,919, with an average of 11,598 B.t.u. per lb. In Table V are given the general averages obtained from these tests. They are divided into three classes. The first class is an average of the ten coals,

fired with a brick arch; the second gives the results of the coal from Macoupin, Ill.; Williamson, Ill.; Sullivan, Ind., and Vermilion, Ind., without the brick arch; while the third gives the results of these same coals with the brick arch.

TABLE V.—AVERAGE RESULTS OF THE ALTOONA TESTS.

Group*	BA—10	NA—4	BA—4
Equivalent evaporation per pound dry coal (lb.)	9.3	8.6	9.2
Boiler efficiency (per cent)	67.7	63.4	67.2
Dry coal per dynamometer horsepower hour (lb.)	4.3	4.6	4.3
Smoke densities (per cent)	23.6	36.5	24.1
Cinders and fuel dust (per cent of fuel fired)	4.56	5.56	4.18
Carbon contained in the cinders and fuel dust (per cent of fuel fired)	3.11	3.79	2.88

*BA—10 = Average of 10 different coals with the brick arch.
NA— 4 = Average of 4 different coals without the brick arch.
BA— 4 = Average of 4 different coals with the brick arch.

From the results of these tests the following summary of the advantages of the brick arch in the firebox were determined:

Increases in number of pounds of water evaporated per pound of coal from 8.6 to 9.2.

Increases of boiler efficiency from 63.4 per cent to 67.8 per cent.

Decrease in the amount of coal consumed per dynamometer h.p.-hour from 4.6 lb. to 4.3 lb.

Decrease in average density of visible smoke emissions from 36.5 per cent to 24.1 per cent.

Decrease in the total average quality of cinders and fuel dust emitted in smoke from 5.56 per cent to 4.18 per cent of the fuel fired.

Decrease in the number of heat units per pound of cinders in fuel dust emitted in smoke from 9,610 B.t.u. to 9,064 B.t.u.

Decrease in the amount of carbon contained in cinders and fuel dust per ton of coal consumed, from 75.8 lb. to 57.6 lb.

Decrease in the number of heat units contained in the ash and clinker discharges per pound of fuel fired, from 6.28 to 4.98.

Decrease in volume of air intermingled with the gases of combustion, discharged through the stack, from 26.5 per cent to 22.5 per cent.

Increases of the portion of the carbon in the fuel which combines with oxygen to form carbon dioxide, from 51.1 per cent to 53.2 per cent.

Table VI gives the results obtained with experienced and with inexperienced firemen operating the locomotive at 80 revolutions per minute and at 25.6 per cent cutoff, burning coal with and without the brick arch in the firebox. The first column is an average of the coals obtained from Marion, Saline, Sangamon, Vermilion and Williamson counties, Ill.; and Greene, Sullivan, Vermilion and Vigo counties, Ind. The last two columns in the table consider the coal from Macoupin and Williamson counties, Ill.

TABLE VI.—RESULTS OF TESTS WITH EXPERIENCED AND INEXPERIENCED FIREMEN.

Test Group*	BA—9—E	BA—9—I	NA—2—E	NA—2—I
Dry fuel fired per sq. ft. grate surface per hr., lb	46.1	57.5	51.5	55.6
Equivalent evaporation per sq. ft. H. S., per hour	7.1	7.2	7.0	7.1
Equivalent evaporation per lb. dry coal	9.7	8.0	8.6	8.2
Boiler horsepower†	700.4	707.7	684.7	711.0
Efficiency of boiler based on fuel per cent	73.2	59.7	65.2	62.7
Dry fuel per dynamometer h.p. hr., lb	3.9	5.2	4.3	4.6
Thermal efficiency of locomotive based on fuel, per cent	5.0	3.9	4.7	4.5
Average smoke density, per cent	18.	36.	27.	31.
Cinders and fuel dust in per cent of fuel fired	3.44	4.00	2.37	2.98

*BA—9—E = Average of 9 different coals with the brick arch and experienced firemen.
BA—9—I = Average of 9 different coals with the brick arch and inexperienced firemen.
NA—2—7 = Average of 2 different coals without the brick arch and with experienced firemen.
NA—2—I = Average of 2 different coals without the brick arch and with inexperienced firemen.
†One boiler horsepower = 34.5 lb. equivalent evaporation per hour.

When burning the same kinds of coal in a locomotive firebox equipped with a brick arch, firing by inexperienced firemen, as compared with that by experienced firemen, results in the following:

An increase in fuel consumption from 46.1 lb. to 57.5 lb. of fuel fired per sq. ft. of grate surface per hour.

An increase in boiler horsepower from 700.4 to 707.7.

A decrease in boiler efficiency from 73.2 per cent to 59.7 per cent.

An increase in fuel consumed per dynamometer horsepower from 3.9 lb. to 5.2 lb.

An increase in smoke density from 18 per cent to 36 per cent.

An increase in cinders and fuel dust discharged in smoke from 3.44 per cent to 4.00 per cent of the fuel fired.

A decrease in thermal efficiency from 5.0 to 3.9 per cent.

A similar comparison of the values obtained when firing the same kinds of coal in a locomotive firebox not equipped with a brich arch shows that firing by inexperienced firemen results in the following:

An increase in fuel consumption from 51.5 lb. to 55.6 lb. of fuel fired per sq of grate surface per hour.

An increase in boiler horsepower from 684.7 to 711.0.

A decrease in boiler efficiency from 65.2 per cent to 62.7 per cent.

An increase in fuel consumed per dynamometer horsepower from 4.3 lb. to 4.6 lb.

An increase in smoke density from 27 per cent to 31 per cent.

An increase in cinders and fuel dust discharged in smoke from 2.37 per cent to 2.98 per cent of the fuel fired.

A decrease in thermal efficiency from 4.7 per cent to 4.5 per cent.

ELIMINATION OF SMOKE AT TERMINALS

As a means of eliminating smoke at engine terminals, roundhouses, etc., the committee referred to various smoke washing devices, calling particular attention to the smoke washing plant of the New York Central at its Englewood roundhouse in Chicago. This plant was described in the *Railway Age Gazette, Mechanical Edition,* for October, 1915, page 511. Referring generally to the smoke washing process, the committee said: "The possibilities of the process have long been understood. Its application has been retarded by difficulties encountered in maintaining the plant in the presence of the corrosive acids developed by the process, and by operating costs arising from the consumption of water and power." Smoke washing as a process of general application is still in an experimental stage. Enough has been accomplished to prove that by means of it practically all the objectionable elements in smoke can be suppressed.

The precipitation of suspended matter and gases may also be accelerated by electrical means. If the products of combustion are made to traverse an electrostatic field, the solid particles may be intercepted. This principle has been employed in the removal of solids from the gases of metallurgical and other industrial furnaces. A few applications have been made in connection with the furnaces of boiler plants; the approaching soot or dust particles responding to electrical influences, attach themselves to the grating as do metallic particles to a magnet. The grating is cleaned by interrupting the current. The New York Edison Company has experimented with this process as a means for the suppression of fuel dust and ash from the stack of one of its stations.

The committee was appointed in March, 1911, and consisted of four members appointed by the mayor, four appointed by the railroads and nine appointed by the Chicago Association of Commerce. The late Horace G. Burt was chief engineer for the committee until May, 1913, and was succeeded by W. F. M. Goss, dean of the Engineering Department, University of Illinois. The report was submitted to the association at a dinner on Wednesday evening, December 1.

INSULATION STRENGTH OF OIL.—The insulation strength of the oil in all transformers used on circuits operated above 6,600 volts in the system of the Georgia Railway & Power Company, Atlanta, Ga., is tested once each month. When the oil shows an insulation strength lower than 40,000 volts it is filtered and tested until this strength is secured. It is well known that a small amount of moisture in oil greatly reduces the insulation strength, and inasmuch as a small sample must be taken for test, it has been found that extreme care must be exercised to secure and deliver the sample to the test room in the same state as that in which it is found in the transformer case. To make this possible a specially prepared 4-oz. sample bottle is furnished to station operators for delivering the monthly samples for test. These bottles are prepared by washing and rinsing in petrol, then dried and the corks inserted. The cork and mouth of the bottle are then dipped in heated paraffin, which seals the bottle air-tight.—*The Engineer.*

Operation of Radial Coupled Axles*

Methods of Driving Articulated Systems from a Single Set of Cylinders; Future Possibilities

BY ANATOLE MALLET, Paris, France

In locomotive construction, it is often necessary to introduce, at one or both ends, carrying axles with radial play, in order to facilitate the handling of curves. Such construction reduces, however, the amount of adhesive weight. Hence, for a long time, arrangements have been sought which would make it possible to transmit power to convergent axles without increasing the number of steam cylinders. These various systems of transmission may be divided into two classes: Those which involve elements having rotary motion; and those which involve elements having reciprocating motion.

TRANSMISSION BY ROTARY MOTION

This class includes gear transmission, transmission by endless chain and transmission by universal joints.

Gear transmissions appear to have been first utilized for operating locomotive axles having freedom of radial movement in 1838, in a locomotive built at Heath Abbey for the Rhymney foundry in Wales. This locomotive was carried on two trucks with two axles each, as shown in Fig. 1, which is reproduced from The Engineer, November 15, 1867. The two trucks could turn so that they were at an angle with each other without throwing the driving gears out of mesh.

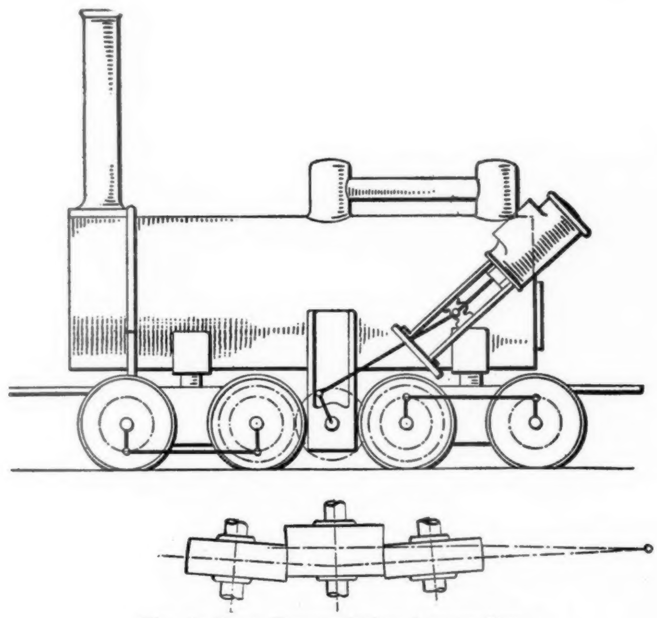


Fig. 1—Gear Transmission Locomotive

In 1841, the Baldwin Locomotive Works built a locomotive in which the rear axles were driven by means of a countershaft and connecting rods, and the axles of the front truck were operated by a gear transmission located on the longitudinal axis of the machine. This locomotive weighed 13½ tons and was designed for use on a quarry railroad. The results were satisfactory, but the type was afterwards abandoned.

The French engineer, Tourasse, presented at the Competition of Semmering in 1851 a design of locomotive with six axles similar to the Rhymney locomotive. This locomotive was to weigh 60 tons with the water carried in a saddle tank on the boiler. The power developed would have been extraordinarily large for that time, since, according to the author of the design, the locomotive was to be able to start with a load of 250 tons over a grade of 2½ per cent. The Locomotive Works of Winterthur, Switzerland, built in 1883, for an industrial railroad in the south of France, a locomotive similar to the one just described. It appears that this type was unsuccessful.

The famous Engerth locomotive built after the Semmering Competition, from which no practical results were obtained, was at first characterized by the use of gear transmission for connecting the last axle of the locomotive to the forward axle of the tender. The arrangement of these gears is shown in Fig. 2. The intermediate shaft, carrying the middle toothed gear is arranged to slide longitudinally in its bearings, if necessary, to cut out the connection with the wheels of the tender. Quite a large number of Engerth locomotives were built. As the gears did not give satisfactory results in actual practice,

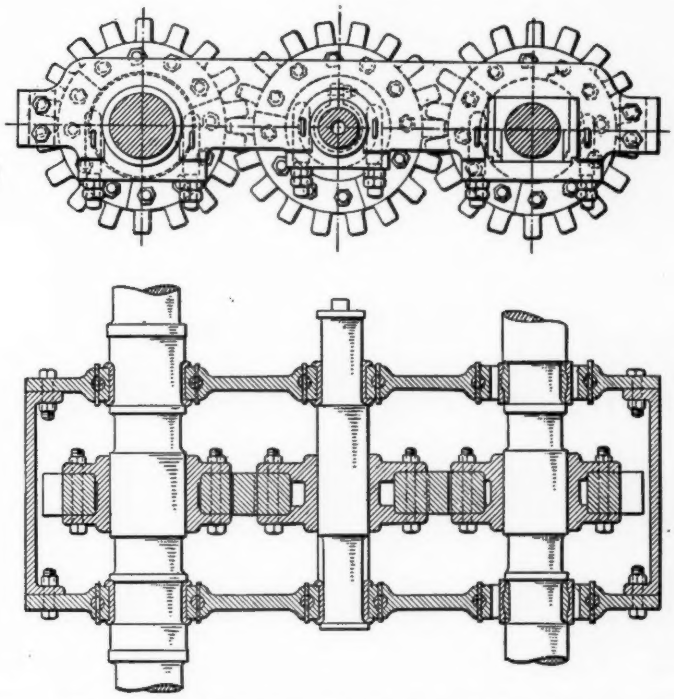


Fig. 2—Gear Arrangement in the Engerth Locomotive

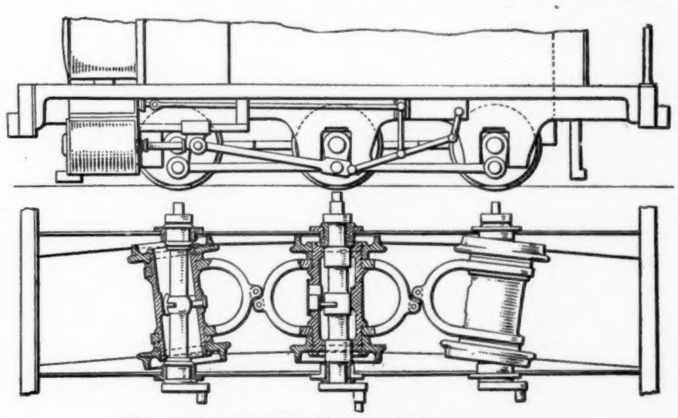


Fig. 3—Haywood's Hollow Axle Locomotive

*Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers in New York, December 7-10, 1915.

however, they were eliminated and the complicated gear transmission type has long since entirely disappeared from practice.

Before 1830, W. N. James, of Birmingham, proposed to connect not only the axles of the locomotive and tender but also those of the cars by means of gear wheels operated by a longitudinal shaft running the length of the train and provided with ball and socket joints to give them the flexibility necessary for making the curves. The locomotives of the Climax, Shay and Heisler systems use this principle, the Climax and Heisler locomotives having been actually built in sizes of 75 to 80 tons and the Shay locomotives, up to 135 tons.

The use of endless chain for coupling axles which may be thrown out of parallelism appears to have been adopted for

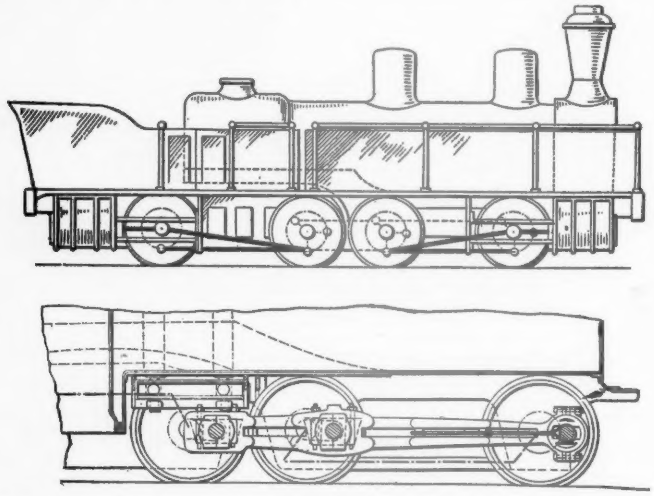


Fig. 4—Central Connecting Rod Arrangement Designed by Société John Cokerill

the first time in 1851, by S. A. Maffei, of Munich, in the construction of the locomotive Bavaria, presented by him at the Semmering Competition. This machine had seven axles, driven by two cylinders. The axles were divided into three groups and the wheels of each group were coupled by external connecting rods, while the groups were connected by endless chains made of links and studs. The engine was given the first prize at the competition. It was said that the victory was due only to the very brief duration of the tests, and that this locomotive could be maintained in good operating condition only by constant repairs to the chain transmissions. As a matter of fact, the Bavaria has never been reproduced in full or in part.

Lievesey, in 1860, devised an arrangement of chains and sprockets, not mounted directly on the axles, but carried on a spherical ball joint in such a manner that the toothed wheels and chains remain always in the same plane. In the United States a type of small locomotive designed to operate over roads made of logs placed end to end is sometimes used in lumbering operations. This locomotive is set on two trucks and its axles are driven by means of chains from a countershaft operated by the cylinder. The wheel treads are groove-shaped, fitting over the log rails on which they run.

The transmission by universal joints may be considered as including all transmissions by ball joints. The term ball joint applies here to any device involving wheels mounted on a hollow axle, in the interior of which is a shaft that receives the power from the steam cylinders and transmits it by means of a ball joint, or universal joint, to the hollow axle. On curves the hollow axles take the radial displacement while the interior shafts remain parallel. The hollow axles are coupled by external rods in such a manner as to make the converging movements of the outer axles and the movement of the transverse displacement of the central axle correspond. This ingenious device appears to have been invented by Percival Haywood, who made use of it about 1880 on a small locomotive running on a 15-in. gage railroad having curves of 16-ft. radius. This transmission is shown in Fig. 3.

E. P. Cowles applied the same principle, but a different arrangement, to a locomotive on a quarry railroad in Kentucky. Only the central carrying axle of each truck was hollow, containing a rigid shaft acted upon by the steam cylinders. The other axles were coupled by external connecting rods, in the middle of each of which was provided a slot for the crank pin of the fixed shaft, which is carried on external supports and is connected with the hollow axle by a central universal joint. The inventor utilized the peculiar idea of operating both trucks from the same cylinders in order to simplify the general construction of the machine. To accomplish this, each piston rod was arranged to pass through both covers of its cylinder and to engage at each end with a connecting rod. Due to the obliquity of these connecting rods, however, their midpoints of stroke did not correspond to each other, and a sliding of the wheels twice in each revolution resulted.

TRANSMISSION BY RECIPROCATING MOTION.

The mechanisms of this class may be divided in the following manner: Coupling of convergent axles by connecting rods located in the longitudinal axis of the engine, these connecting rods being either simple or double, rectilinear or triangular; coupling by oscillating levers or equalizers; use of a free axle coupled by connecting rods to the converging axles, and coupling of axles by means of external connecting rods of which the length varies with the radial displacement of the axles.

The use of central connecting rods acting on spherical crank pins located in two contiguous axles is a very simple idea, but there is serious difficulty in passing the dead center. This can be remedied in several ways. Fig. 4 shows a design of locomotive presented by the Société John Cokerill to the Semmer-

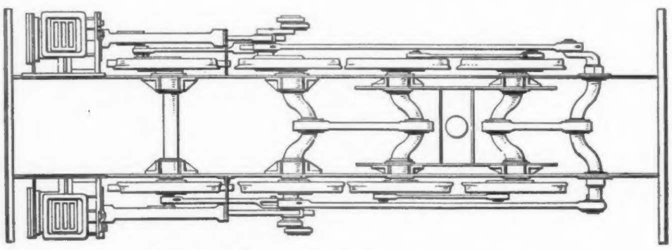


Fig. 5—Aliges' Four-Axle Locomotive

ing Competition. In this design two cylinders act on the two front axles while two other cylinders act on the two axles of the truck in the rear. The first axle of this truck is coupled to the two axles of the engine by a central connecting rod engaging with three axle cranks. This design is referred to here because of the arrangement of center coupling. It has never been put into practice.

Thouvenot took up the idea of locating rods on the axis of engine about 1860. He deflected the connecting rods so as to bring them back into the axis of the engine, the crank-axles being so designed as to bring both cranks on the longitudinal center line. This arrangement does not appear to possess sufficient strength.

C. Aliges, former engineer of the Cail factory in Paris, developed a design for a four-axle locomotive (Fig. 5), in which one of the two axles forming the truck was connected with the driving shaft by a central connecting rod and the other with the third axle by a like arrangement.

The idea of using oscillating levers for coupling convergent axles was first disclosed about 1855 in an invention by Lucien Rarchaert. There is a model of this arrangement in the gallery of the Conservatoire des Arts et Métiers in Paris, but the system itself has never been actually used.

A German engineer, Christian Hagans, invented the arrangement shown in Fig. 6. The axles of the truck were acted upon by a vertical lever *a*, oscillated through the intermediary of a

longitudinal rod by lever *a'*, oscillated by the piston rod. The upper end of the lever *a* is connected to the top of an equalizer *b*, pivoted in the middle and having its lower extremity attached by a distance rod to the rear axle *c*, of the truck. The result of this arrangement is that if, on curves, the axles of the truck are displaced, the lower part of the lever *a* has a displacement in the same direction and to the same amount, so taking care of the convergence of the axles. The Hagans system was at first considered quite a success on the Prussian State Railroads on five-axle coupled locomotives weighing 72 tons in service, but it has since been entirely abandoned because the introduction of locomotives with five axles, parallel and coupled by ordinary side rods, has made it unnecessary.

The Johnstone system, which has been applied on several large duplex locomotives built in the United States for the Central Mexican Railroads, has some resemblance to the preceding type. Fig. 7 shows one-half of this locomotive, the other half being entirely similar. The piston rod acts on the middle of a lever *a*,

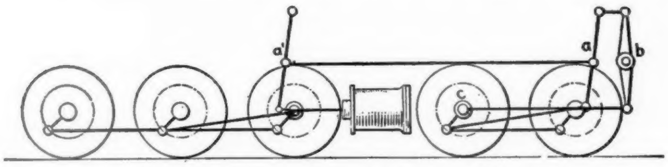


Fig. 6—Hagen's Five-Axle Locomotive

which is vertical when in its normal position. The main connecting rod is attached to the lower extremity of this lever while from the upper extremity a short coupling rod connects to the top of equalizer *b*. This equalizer oscillates about its middle and operates from its lower end a connecting rod to a crank pin set at 180 deg. from the working pin of the counter-crank. The lever *a*, to which the piston rod is attached, moves always parallel to itself, vertically on straight track and at a slight incline on curves.

The use of a free axle coupled by connecting rods with radial axles appears to date back to the Semmering Competition. Maffei there presented several designs in which the axles of locomotives and their tenders were coupled by inclined or triangular connecting rods. A similar design (Fig. 8), submitted at the same Competition by a Hannoverian engineer, Kirchweger, shows a locomotive carried on two trucks having two axles

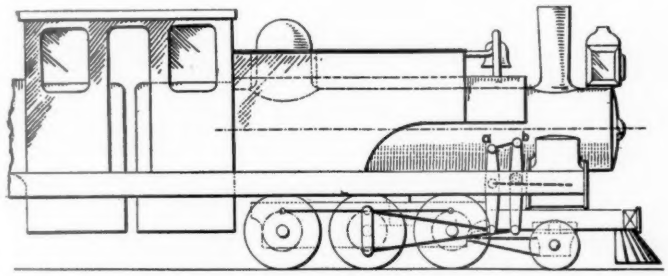


Fig. 7—Johnstone System of Equalizer Transmission

each, the coupling of the trucks being effected by an arrangement of this kind. It may be seen that there is a connection between the journal boxes of the wheel axles and of the free axle.

The Austrian engineer, Pius Fink, tried to retain in the Engerth machine its original property of total adhesive weight by substituting for the gear train an articulated device, using a free axle. These locomotives were in service for several years.

Rarchaert, after having abandoned the system of oscillating levers, designed an arrangement coming under the present category (Fig. 9). This was applied on a locomotive with two trucks having two axles each. The cylinders operated a free axle coupled with the carrying axles by a triangular central connecting rod. The pins of the cranks had spherical heads. The locomotive gave good results, but at the death of the inventor experiments with it were discontinued. It is of interest to recall that the author of this ingenious system was a watchmaker.

The well-known designer, Krauss, of Munich, proposed in 1893, an arrangement permitting of the operation of the axles of a truck by steam cylinders carried on the main frame of the engine, as shown in Fig. 10. To accomplish this, the crank pins on the driving shaft carry pin blocks working in slots in the trussed connecting rods. The use of such connecting rods is subject to serious objections. Stress is exerted on the crank pin in a vertical direction only and, moreover, the pin blocks have on curves a periodic displacement in a direction transverse to the axis of the connecting rod. None of these systems appear to have been utilized practically.

Under the classification of external connecting rods, the lengths of which vary with the convergence of the axle, reference will be made first to the Klose system, which has been fairly widely applied. It may be seen from this figure that the crank pin of the working axle carries a kind of rocker lever to two points of which are connected the coupling rods of the other axles. The other two points are connected to the extreme axles by a system of connecting rods and triangles in such a

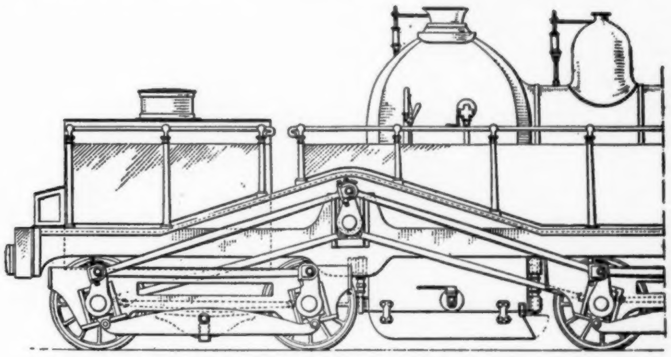


Fig. 8—Kirchweger Free-Axle Locomotive

manner that the convergence of the axles corresponds to the variation in length of the coupling rods. This system has been employed in locomotives having a gage of 5.77 ft. on the Bosnian-Herzegovinian Railroads and on large five-axle locomotives of the Wuerttemberg State Railroads.

In the Vogel system (Fig. 11), it has been proposed to couple the fixed axles of the locomotive with the axle of a pivoting truck placed under the tender. The crank pin of the wheel glides in a slot cut in the external connecting rod and the main rod connects with the spherical head of an equalizer connecting the two coupling rods. This system appeared in 1878.

CONCLUSION.

An examination of these devices gives the impression that all of them involve a serious inconvenience, and that all of them can operate in a satisfactory manner only when they are in vertical play, parallel to the longitudinal axis of the engine, *i. e.*, when the latter runs along straight sections of track. More than fifty years ago, J. J. Meyer, author of the first system of articulated locomotives which has given practically satisfactory results, wrote the following: "In the systems proposed for coupling in a rigid manner in whatsoever way it may be, the several axles belonging to two diverging trains, the addition of coupling mechanism introduces a greater complication than the addition of two extra steam cylinders, and the maintenance of these mechanisms, as well as keeping the drive wheels rigidly to the same diameter, will be of greater cost than that of the two extra cylinders and the two mechanisms, without taking into consideration the loss in efficiency."

DISCUSSION

E. A. Averill: It is possible in a two-cylinder locomotive to obtain a tractive effort around 100,000 lb. as far as the cylin-

ders are concerned. In view of the limitations of a satisfactory factor of adhesion and safe weight on each driving axle, such a tractive effort would necessitate the use of 12-coupled drivers, which means a driving wheel base of approximately 26 ft. 6 in. for drivers 60 in. in diameter. Such a rigid wheelbase would be impossible for ordinary use, with no arrangements allowing sidewise action of the driving wheel other than the setting in of the tires or the use of blind tires. We have reached a tractive effort of nearly 85,000 lb. and a wheelbase of 22 ft. It is not a very great step from that to 100,000 lb., a step that is desired and probably will be undertaken, but there is an important problem to solve in connection with this very long wheelbase.

W. F. Keisel, Jr. (Pennsylvania Railroad): Apparently few of the designs shown in Mr. Mallet's paper have reached the

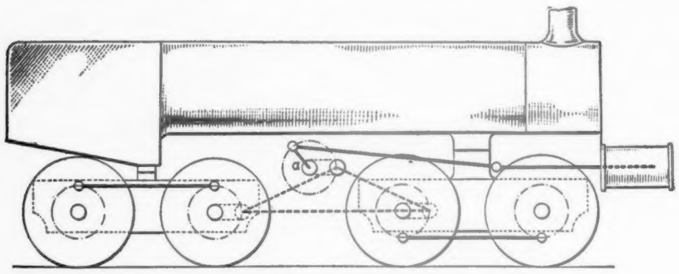


Fig. 9—Rarchaert's Free-Axle Design

experimental stage and none have come into general use. This is sufficient indication that their practicability is doubtful. The further fact that other solutions of the problem, less expensive and complicated, have been found would lead to the conclusion that such schemes will probably never be adopted, their only advantage being that all the axles can be driven from a single set of cylinders.

The weight and size of modern locomotives are so great that the cylinder diameters are now as large as road clearances will permit. If larger locomotives are built, the application of two or more sets of cylinders will probably be obligatory. If the number of sets of cylinders is increased the Mallet type is the logical type to use, as no change in the customary construction

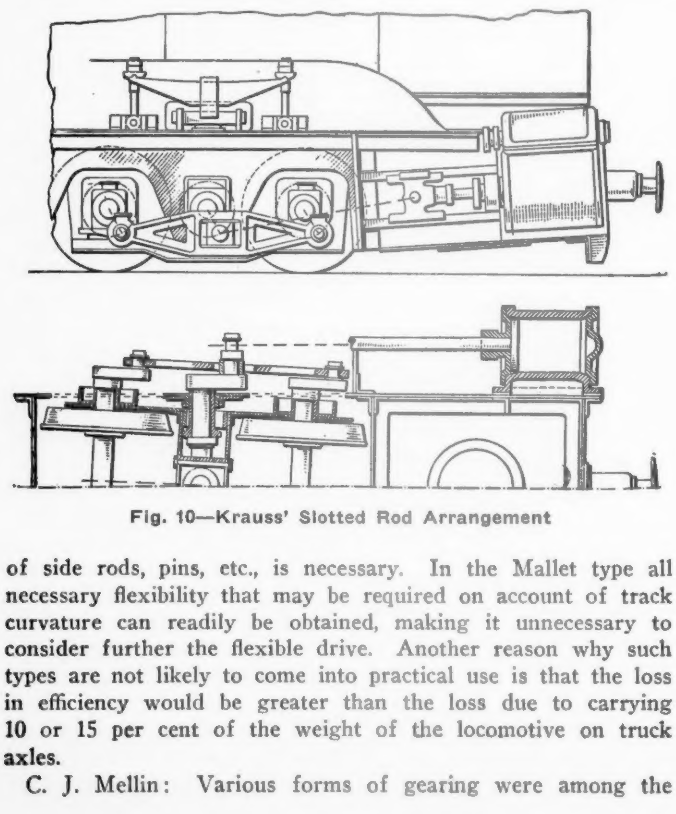


Fig. 10—Krauss' Slotted Rod Arrangement

of side rods, pins, etc., is necessary. In the Mallet type all necessary flexibility that may be required on account of track curvature can readily be obtained, making it unnecessary to consider further the flexible drive. Another reason why such types are not likely to come into practical use is that the loss in efficiency would be greater than the loss due to carrying 10 or 15 per cent of the weight of the locomotive on truck axles.

C. J. Mellin: Various forms of gearing were among the first means sought to transmit motion from one set or group of axles to another. This has probably been the most successful principle applied for this purpose. The application of chains for the transmission of power from one axle to another was also tried at an early date, but probably owing to defective or weak chains, it was abandoned at the outset and reintroduced at a comparatively recent time on log engines. A number of such engines have been built and are reported giving satisfactory service, the chains permitting greater freedom of the axles than the coupling rods, on a rough road bed.

Theoretically the nearest correct method for self-alignment of individual axles on curves is that developed by Haywood (Fig. 3). The axles not only assume a radial position, but the entire wheelbase conforms to the curve, the middle axle being forced out against the outer rail. It does not appear, however, that it can be applied to any but light engines, due to the unfavorable carrying of the weight on the crank axles at the ball connections in the middle between the frames. It is also a question whether the wheels will run steady on a straight track, as it appears that they are liable to wabble from one rail to the other, being confined only by the single ball in the hollow axle.

G. R. Henderson: When a large number of axles are operated by one pair of cylinders, we have the following objectional features: Large and unwieldy cylinder proportions and parts; great loads on rods, crossheads, guides and main crank pins; heavy rods and reciprocating parts; increased difficulty in

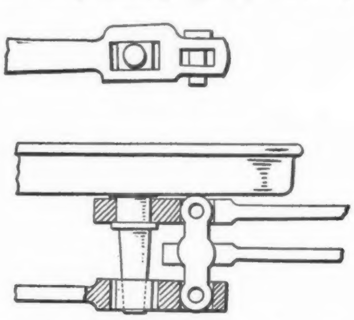


Fig. 11—Vogel System of Offset Rods

lubricating the bearings and rubbing surfaces; greater labor in making round house repairs and adjustments. When operating on the road the most objectionable feature is found in the loss of headway due to slipping of the drivers, practically stalling the train on heavy grades, whereas, in the Mallet type of locomotive, it is a well-known fact that the drivers of both high and low pressure units practically never slip at the same time. This is one of the most valuable features of the Mallet type locomotive and ordinarily is not given sufficient consideration in selecting locomtives for heavy drags.

W. E. Woodard (American Locomotive Company): From the standpoint of tracking, the problem of operating a long coupled wheelbase with a single pair of cylinders could undoubtedly best be solved by arranging certain of the wheels so that they could deflect radially. However, this involves mechanical difficulties which, so far, have appeared to be difficult to solve, at least for heavy locomotives. A practical solution would seem to be a compromise construction which permits of lateral motion of certain of the coupled wheels in a plane parallel with the other coupled axles. A comparatively simple side rod construction can be used which will readily take care of the side motion required. The Zara and other similar truck constructions, which have been used abroad, are based on this general principle. Floating coupled axles in which an abnormal amount of lateral play is allowed to accommodate the curving of the wheelbase, have also been used abroad and to a limited extent in this country. Floating axles with lateral play will certainly allow long wheelbase engines easily to pass sharp curves, but their use is open to the objection that they do not contribute any guiding effort on curves, or steadying action on tangent track, until the full lateral play is taken up. Moreover, because

such axles are free to move laterally, almost all the flange wear comes on those coupled wheels which have normal lateral play. The ruling of the Interstate Commerce Commission, lately made, covering allowable lateral play between driving wheel hubs and driving boxes, is also an objection to this construction.

It is evident that the design of lateral motion coupled axles which will best meet the conditions of the case should be capable of application to any or several pairs of the coupled wheels. Thus it may be desirable to equip the first and last coupled axle with a lateral motion device, or possibly even the first, last and middle pairs of wheels. There has recently been placed in service an arrangement of lateral motion coupled axle which meets these requirements. It provides sufficient flexibility to admit of a locomotive with a long driving wheelbase curving easily and at the same time affords a definite resistance against lateral motion. This design is in successful operation on a number of heavy 10-coupled locomotives on the New York, Ontario & Western and has also been used on a similar class of locomotives of unusual weight and power just going into service on the Erie Railroad. Briefly, the design consists of an arrangement which permits of about 2 in. total side play of the leading coupled wheels and boxes. This lateral motion is resisted and controlled by a constant side resistance which is obtained through the action of the load carried on the boxes. In this way, a positive gravity control is obtained against an initial side motion of the wheels and throughout the entire range of this motion up to its limit. The side rods connecting this pair of driving wheels with the second pair of wheels are arranged with ball knuckle-joint pins and a special design of spherical crank pin. The New York, Ontario & Western 2-10-2 type engines have 28-in. by 32-in. cylinders, 57-in. driving wheels, a rated tractive effort of 71,200 lb. and a driving wheelbase 20 ft. long. The Erie 2-10-2 type has 31-in. by 32-in. cylinders, 63-in. driving wheels, a rated tractive effort of 83,000 lb. and a driving wheelbase of 22 ft. 6 in. In both designs flanged tires are used on all the driving wheels. These engines pass readily around yard curves of 20 deg. without cramping or grinding.

The principle of applying a yielding resistance to control the motion of the driving axle having lateral play appears to be fully justified by the results of operation so far obtained. Observations of the engines in service show that there is no lateral motion of these wheels on tangent track and on ordinary line curves, even when the engine is working very hard at moderate speeds. The tire wear also appears to be about evenly divided between the first and the second driving wheels. These applications seem to justify the expectation that this construction can readily be extended to a 12-coupled locomotive having lateral motion driving axles front and back. With such a locomotive, a tractive effort of 100,000 lb. with a single pair of cylinders could be obtained within the limit of wheel loads which have been used on a number of existing locomotives. The construction is also applicable to Mallet locomotives, thus increasing the number of pairs of coupled wheels in each unit.

Geo. L. Fowler: I have made a few investigations relative to lateral wheel pressures on curves, and have gotten what were, to me, astonishing results. There is one thing that stands out very clearly and that is the fact that the leading truck has a very material effect upon the distribution of the lateral thrust. I found that in negotiating curves, the leading truck of a Consolidation locomotive has the greatest amount of pressure on the rail, then comes the second driver, followed by the first driver, the third driver and fourth driver, in the order named. Turning the engine around and running it backward, the rear wheel strikes a tremendous blow and the rest of the wheels travel around with very little pressure. The same thing was manifest in connection with Pennsylvania electric locomotives. The leading driver on the rear unit put most of the pressure on the rail. I have never investigated the Mallet type, but I believe the blow from the leading wheel of the second unit would be a pretty serious thing at high speeds on sharp curves. As to switch engines and Consolidation locomotives running backward, I believe the speed should be limited to not more than 20 or 25 miles an hour.

The easiest riding locomotive is the old American type, followed by the Pacific type, if the weight is not considered. With the latter type the lateral pressure from the trailing wheel was invariably much higher than that from the rear driver. The pressure in the case of tenders was very light, but with a train negotiating a sharp curve at high speed, the effect of the locomotive is slight compared with that of the sleeping cars following. With a Pacific type locomotive pressures were recorded from 13,000 lb. to 14,000 lb. for a single wheel, followed by a sleeping car with 32,000 lb. to 36,000 lb.

In regard to the limitation of lateral motion in the driving boxes, I could find no difference in a large number of engines on curves, where the engine apparently bears over against the outer rail, but on tangent track side motion is an important factor. A dilapidated locomotive, with from 1½ in. to 1¾ in. side motion and just ready to go into the shop, slides over a tangent track with an ease that is surprising. With about ⅜ in. lateral motion, heavy blows may be expected.

E. B. Katte (New York Central): Some experiences derived in the development of the earlier types of high-speed electric locomotives do not agree with Mr. Fowler's experience in regard to lateral motion. We found in the early type of electric locomotive, which only had a two-wheel guiding truck, that if there were considerable lateral motion, either in running into a curve, or in running off a curve, there was a tendency to throw over from one side to the other. The effect of the low center of gravity was accentuated by the lost motion, and we would gradually get such a cumulative shock at speeds of 80 or 85 miles an hour that we would break the track, which was relatively light. Taking the same locomotive with hardly any lost motion, we could run it at almost any speed without getting a knock against the rails.

W. E. Woodard: I do not see why it should not be possible to provide cylinders large enough to take care of 12-coupled drivers, although they will slightly exceed the sizes we have been using up to this time. The 12-coupled locomotive would probably take a 32-in. or 33-in. cylinder, well under the size of cylinders used on the Mallet. If any one had said anything a short time ago about building 85,000-lb. tractive effort units we would have thrown up our hands, but we have done that. I see no obstacles to prevent going up to a simple locomotive with 100,000-lb. tractive effort.

On the New York, Ontario & Western engines there are no indications whatever of the driver deflecting under the most severe working of the engines, even at seventy-five revolutions per minute, when there was the greatest tendency to nose. In fact, an indicator on the lateral motion device showed no deflection on any curve or tangent track except when going over a cross-over, or a very sharp turn-out in the yard.

C. D. Young: I can see no particular difficulty in reaching 100,000-lb. tractive efforts, but I do not believe that the use of two cylinders is the way to do it. It should be done either with two pairs of simple cylinders, or with three simple cylinders. In that way the long overhang of the main pin, which would result from the wide spread, would be overcome, as well as the trouble with cylinder clearances. If the cylinders were made large enough to limit the full gear position to a reasonable cut-off, I believe a boiler could be made which would develop the possibilities of 100,000-lb. tractive effort. I see no use, however, for such a locomotive if the boiler will not supply the steam. There should be three or four cylinders large enough to permit the valve gear to be so arranged that the maximum cut-off would not be over 65 or 70 per cent, thus making it possible to develop full tractive effort at a reasonable water rate. The water rate of the two-cylinder engine, working full gear at seven or eight miles an hour, is about 31 lb. per hp. hr. with 225 deg. of superheat. If the cut-off is reduced 50 per cent the water rate drops to 18.5 lb.

EXAMPLES OF RECENT SWITCHING LOCOMOTIVES OF THE 0-6-0 AND 0-8-0 TYPES

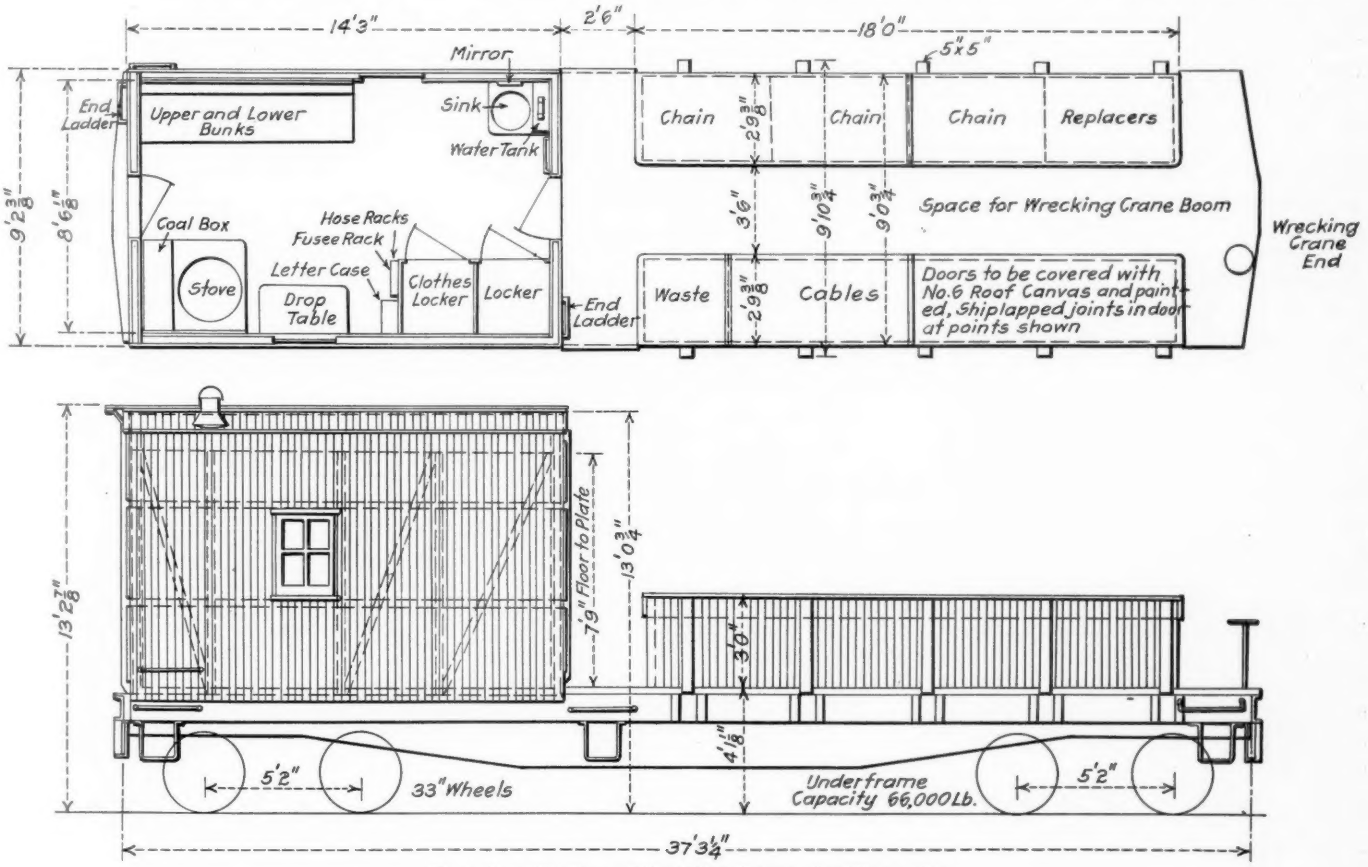
Type	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-6-0	0-8-0	0-8-0	0-8-0	0-8-0	0-8-0
Name of road	S.P.&S.	K.C.S.	C.R.I.&P.	I.C.	N.Y.C.	T.R.R.A. of St.L.	Sou.	Erie	Penn. Lines	N.Y.C.	N.E. Gas & Coke Co.	N. J. Zinc Co.	L. & J. Bridge Co.	Birm. Sou.	Buffalo Creek	C.&W.I.	Wash. Sou.	N.Y.C.
Road number or class	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Builder	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
When built	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Tractive effort, lb.	31,200	34,300	32,950	34,400	33,140	45,500	32,015	29,952	36,092	33,130	38,200	37,800	37,000	43,500	45,200	49,000	49,600	49,500
Weight, total, lb.	152,000	158,000	162,000	169,000	172,000	198,000	143,200	153,100	168,100	162,300	152,400	154,450	165,000	196,000	206,000	216,000	229,000	240,000
Weight on drivers, lb.	152,000	158,000	162,000	169,000	172,000	198,000	143,200	153,100	168,100	162,300	152,400	154,450	165,000	196,000	206,000	216,000	229,000	240,000
Maximum weight on one pair of drivers, lb.	51,800	54,600	53,800	57,500	60,200	67,000	53,200	51,600	57,400	57,000	51,650	54,400	56,500	51,600	52,000	55,500	59,300	60,400
Weight of tender, lb.	95,500	112,500	106,200	101,400	101,900	135,000	93,300	95,600	132,000	102,400	88,000	98,500	101,400	103,000	109,600	146,000	183,400	148,300
Wheel base, driving, ft. & in.	11—0	11—6	11—0	11—8	11—6	12—0	11—0	11—0	11—6	11—6	13—6	11—0	11—6	15—0	14—6	15—6	15—6	16—0
Wheel base, total engine, ft. & in.	11—0	11—6	11—0	11—8	11—6	12—0	11—0	11—0	11—6	11—6	13—6	11—0	11—6	15—0	14—6	15—6	15—6	16—0
Wheel base, total engine and tender, ft. & in.	41—10	44—2	42—6	44—2	42—7	47—1¼	43—4¾	42—6¼	48—6¼	42—6¼	43—4½	43—10	42—7	44—11¾	47—9½	50—7¾	57—3	53—8½
Diameter of drivers, in.	51	50	52	51	57	51	51	50	56	57	51	51	51	53	51	57	51	58
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter	20	20	20	21	21	22½	20	20	22	21	21	22	21	22	22	24	24	25
Cylinders, stroke	26	28	28	26	28	30	26	26	24	28	26	26	28	28	28	30	28	30
Valve gear, type	......	Wals.	Baker	Wals.	Wals.	Wals.	Steph.	Steph.	Steph.	Wals.	Steph.	Steph.	Wals.	Steph.	Wals.	Baker	Baker	Wals.
Steam pressure, lb.	180	180	180	180	180	180	185	180	205	180	200	180	180	200	200	190	185	180
Boiler, type	Straight	E.W.T.	E.W.T.	E.W.T.	Straight	Straight	E.W.T.	Straight	Belpaire	Straight	Straight	Straight	Straight	Straight	E.W.T.	E.W.T.	Straight	E.W.T.
Boiler, outside diameter, front end, in.	72¾	62	63¼	66¼	67¼	80	63	68¼	68¾	67⅜	72	74	67⅜	80	74½	74¼	80	72⅛
Tubes, number and diameter, in inches	192—2	152—2	151—2	163—2	165—2	230—2	300—2	302—2	323—2	165—2	325—2	335—2	163—2	440—2	224—2	214—2	184—2¼	214—2
Flues, number and diameter, in inches	25—5½	22—5½	21—5½	21—5½	22—5½	28—5½	......	......	......	22—5½	......	......	22—5½	......	30—5½	32—5⅜	34—5½	30—5½
Length of tubes and flues, ft. & in.	11—0	12—6	16—0	14—9	16—0	14—6	15—1½	11—6	13—11¼	16—0	13—6	10—6	16—0	15—0	15—0	14—9½	14—9½	16—6
Heating surface, tubes and flues, sq. ft.	1490	1381	1739	1695	1879	2317	2376	1805	2342	1896	2283	1826	1862	3436	2394	2310	2314	2548
Heating surface, firebox, sq. ft.	144	145	114	139	129	175	110.5	152	152	125	137	169	126	170	167	191	191	179
Heating surface, arch tubes, sq. ft.	......	......	13	15	13	16	......	20	......	15	......	......	13	......	22	15	22	25
Heating surface, total, sq. ft.	1634	1526	1866	1849	2021	2508	2486.5	1977	2494	2036	2420	1995	2001	3606	2583	2516	2527	2752
Heating surface, superheater, sq. ft.	280	310	380	360	380	460	......	......	......	396	......	......	403	......	523	547	720	580
Heating surface, equivalent,* sq. ft.	2054	1991	2436	2389	2591	3198	2486.5	1977	2494	2630	2420	1995	2606	3606	3368	3337	3607	3622
Grate area, sq. ft.	28.0	42.0	31.7	43.0	32.6	41.1	29	52.3	41.25	32.6	40	57	32.7	48.0	47.5	50.2	55.0	53.3
Firebox, length, in.	96	84	68	86	72	84	66	114¼	90	72⅛	96 3/16	113 11/16	72⅛	96	96	120	120	102
Firebox, width, in.	42	72	67¼	72	65¼	70¼	66	66	66	65¼	60⅛	72⅛	65¼	72	71¼	60¼	66	75¼
Kind of fuel	Oil	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Coke	Ant. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal	Bit. Coal
Tender, water capacity, gal.	4000	5600	5000	5000	5100	7000	4500	4500	5500	5100	4000	4500	5100	5000	5500	7400	10,000	7500
Tender, fuel capacity, tons or gallons	1900	8	7½	6½	7½	12	7	7	6	7½	8	8	7½	8	8	14	15	14
Weight on drivers ÷ tractive effort	4.87	4.61	4.92	4.91	5.19	4.35	4.47	5.11	4.65	4.89	4	4.09	4.46	4.51	4.56	4.41	4.62	4.85
Total weight ÷ tractive effort	4.87	4.61	4.92	4.91	5.19	4.35	4.47	5.11	4.65	4.89	4	4.09	4.46	4.51	4.56	4.41	4.62	4.85
Tractive effort X diam. drivers ÷ equivalent heating surface*	774.6	861.3	703.3	734.3	729.0	725.6	656.6	757.5	810.4	718.0	805	966.3	724.3	639.3	684.5	837.1	701.3	792.6
Equivalent heating surface ÷ grate area	73.35	47.4	76.84	55.55	79.47	77.81	85.74	37.7	60.46	80.67	60.5	35.0	79.66	75.12	70.89	66.45	65.58	67.95
Firebox heating surface ÷ equivalent heating surface*, per cent	7.01	7.28	4.68	5.82	4.98	5.47	4.44	7.68	6.09	4.74	5.66	8.47	4.83	4.71	4.96	5.72	5.30	4.94
Weight on drivers ÷ equiv. heat. surface*	74.0	79.35	66.5	70.74	66.38	61.91	57.59	77.44	67.40	61.71	62.97	77.41	63.34	54.35	61.17	64.73	63.48	66.26
Total weight ÷ equiv. heat. surface*	74.0	79.35	66.5	70.74	66.38	61.91	57.59	77.44	67.40	61.71	62.97	77.41	63.34	54.35	61.17	64.73	63.48	66.26
Volume both cylinders, cu. ft.	9.45	10.18	10.18	10.42	11.22	13.8	9.45	9.45	10.56	11.22	10.42	11.44	11.22	12.31	12.31	15.71	14.66	17.04
Equiv. heating surface* ÷ vol. cylinders	217.3	195.57	239.29	229.27	230.92	231.73	263.12	209.20	236.17	234.4	232.24	174.38	232.21	292.93	273.55	212.38	246.04	212.55
Grate area ÷ vol. cylinders	2.96	4.13	3.11	4.13	2.91	2.98	3.06	5.53	3.90	2.90	3.84	4.98	2.91	3.90	3.86	3.20	3.75	3.13

*Equivalent heating surface = total evaporating heating surface + 1.5 times superheater heating surface.

CAR DEPARTMENT

AUXILIARY CAR FOR WRECKING CRANE

The engraving shows a well-arranged auxiliary car which has been developed on the Canadian Northern and made standard for use with wrecking cranes on that road. One end of the car is enclosed for a length of 14 ft. 3 in. This compartment is fitted with two bunks, one upper and one lower, a stove, a sink, a drop table, a clothes locker and a tool and supply locker. Along the sides of the open portion of the car are weatherproof bins about 2 ft. 6 in. wide inside, divided into sections in which are stored cables and chains of various sizes together with a supply of waste. These bins are 3 ft. high and between them is a space 3 ft. 6 in. wide within which hang the crane hooks when the wrecking train is made up. The train consists of the crane, the auxiliary car, a tool car, a flat car for trucks, blocking, etc., and a boarding car for the crew, in the order named from the locotive. The auxiliary car was developed by A. L. Graburn, assistant superintendent rolling stock of the Canadian Northern.



Canadian Northern Wrecking Crane Auxiliary Car

THE CAUSE OF SHOCKS IN LONG FREIGHT TRAINS*

The Master Car Builders' Association Committee on car construction has stated that the intensity of end force on freight cars is assumed to be equivalent to 250,000 lb. static, which may be concentrated on the center line of the draft gear, or distributed between the draft gear and end sill. The point of contact between the horn of the coupler and striking plate is assumed to be 2 in. above the top of the coupler shank. For a shank 5 in. deep, the distance from the center line of draft gear to the assumed point of contact of coupler horn is 4½ in. This is the first time, to my knowledge, that any mechanical body has ever conceded that the center line of end force is above the center line of the coupler. This is as it should be, as there is no draft gear of sufficient capacity to entirely absorb this end force. I do not think that the assumed 250,000 lb. is sufficient. The assumed end force should be not less than 400,000 lb. static, basing my opinion on what I see in the field, and the tests made by Prof. Ensley during the past year. The statement was made by D. F. Crawford, general superintendent motive power, Pennsylvania Lines West, at Atlantic City last June, referring to the tests made in 1903 and 1904 with a dynamometer car: "At that time it was found that the shock recorded by the dynamometer car was about 100,000 lb. per mile per hour, up to six miles per hour, when the entire capacity of the dynamometer car, which was some 615,000 lb. was absorbed." Using this as a basis, let us see what we find in everyday service. First, take a level yard, where the switching is usually done by a switching crew of three men. Do you find any of them setting brakes to diminish impact with other cars? Do they switch cars at less than four miles per hour? The hump yard conditions are somewhat improved because there are usually enough men to ride all cuts of cars that go over the hump. But the worst of all are our road conditions, due to the slack in our trains.

The heavy shocks in trains are sometimes attributed to the recoil of the draft gear, but this is not the case. They are

* From a paper by H. C. Priebe, Chicago Steel Car Company, read before the Car Foremen's Association of Chicago, December 13, 1915.

caused by the slack in the train. Many shocks occur every day and it is only when actual damage is done or passenger trains delayed that the trainmen will even report them.

The M. C. B. coupler committee has been working on a new standard coupler for some time. The only objection I have to this coupler is the size of the slot. In the present coupler we have a 5⅛ in. by 1¼ in. slot. In the new coupler we should have an opening for at least a 7 in. by 1¾ in. key. The bearing area in both the coupler and key is insufficient and is one of the many causes of so much slack in our trains.

Attention should also be directed to the draft gear, which is the greatest slack producer we have. The M. C. B. committee sent out a circular of inquiry early in 1915, with a number of questions for the purpose of finding out general practices. One of the questions was: "What is your recommendation for coupler travel in connection with high capacity draft gears?" Of the replies, 36 per cent. expressed a preference for more coupler travel than the present standard of 2¾ in. between coupler horn and striking plate, some of them as high as 5 in. It is strange that so many people overlook the fact that in train service there are always two draft gears between two cars, and every time the draft gear travel is increased one inch, the movement between two cars is increased four inches, and the slack two inches.

To illustrate, many modern friction draft gears have a travel of 3¼ in. This allows the coupler to move in 3¼ in. and out 3¼ in. from the normal position, allowing each coupler to move 6½ in. As there are two couplers between two cars, we have 13 in. of actual movement without considering clearance between knuckles, which will average another inch, making a total of 14 in. between each two cars in a solid steel train. Thus in a train of 100 cars, we have 116 ft. 8 in. of movement between cars, of which there is 62 ft. 6 in. of slack and 54 ft. 2 in. of resistance when new. After a year of actual service the gears will have lost another inch of resistance due to the wearing down of friction surfaces; we then have but 37 ft. 2 in. of resistance and 79 ft. 2 in. of slack, and so on. The result is the growing cost of freight car repairs. We are trying to absorb momentum with the draft gear, that should be controlled by the brakes. My experience has been that whenever an engine fails to start a train with resilience enough to equal one revolution of the drivers, it will be unable to take the train to destination. Then, why should there be 60 ft. or more of slack, in addition to the resilience?

Drawbar resistance should be increased and the travel should be reduced to produce results without depending on the engineer's judgment as to how much slack he can take with safety. The facts are that excessive drawbar travel produces excessive slack; and while the draft gear may act as a shock absorber, slack is certainly a shock producer. Trainmen can be instructed on the book of rules, bulletins may be posted, additional traveling engineers employed, but slack cannot be reduced by such methods. Emergency applications of air brakes are bound to take place; therefore the slack must be reduced to avoid collision shocks in road service.

If we must have friction to retard momentum let us have it on the brake shoes which can be properly adjusted and removed when worn out without going to the repair track, and insist that the brakes be used for this purpose, instead of the draft gear.

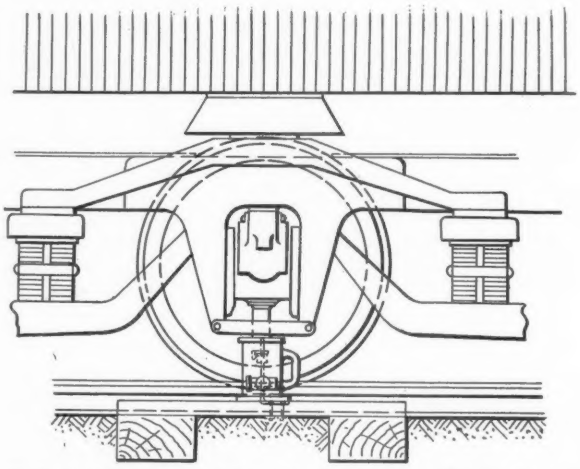
The best results in railroad train service were obtained when the resistance in the end of the cars exceeded the carrying capacity of the cars. Today the capacity of the cars exceeds the capacity of the draft gear. Go out in any yard when tonnage trains are pulling out and you will find 90 per cent of the draft gears stretched out absolutely dead by a locomotive with a tractive effort of less than 70,000 lb. I find that most of the friction draft gears are creepers, and will become dead under sudden jerks, thrusts, or constant load and remain so until the load is entirely removed, not having return power enough to come back under the strain of an ordinary engine. I also find this to be true in placing friction springs in car trucks; the capacity of the springs exceeding by far the capacity of the standard coil truck springs, yet when forced down going over rough track they remain dead, absolutely worthless until the load is removed.

The greatest argument against the spring gears is a supposed recoil, but recoil we must have or we have no draft gear. If the recoil were as great as some people say it is, some of our trains would be aeroplanes, as no one hesitates to place sufficient springs in the trucks of cars to properly carry the load.

WHEEL CLAMP AND JACK BLOCK

A combination wheel clamp and jack block for use with journal jacks when changing brasses is shown herewith. This device was developed by H. J. White, supervisor of car work, Canadian Northern, Eastern Lines, and is extensively used on that system.

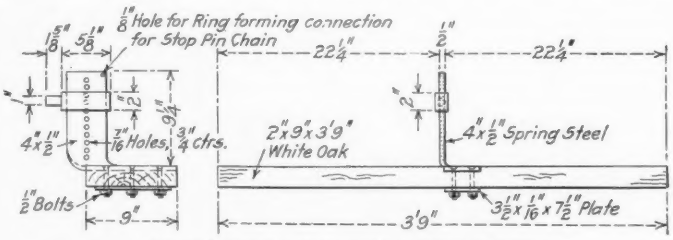
The jack block is a 2-in. by 9-in. white oak plank 3 ft. 9 in. long, to the center of which is attached an upright piece of spring steel 4-in. wide by ½-in. thick. This extends to a vertical



Method of Using Combined Jack Block and Wheel Clamp

height of 9¼ in. above the block and is provided with a number of 7/16-in. holes spaced ¾ in. apart on its vertical center line. A band sliding over the upright piece is provided at one end with a 1⅝-in. projection 1 in. in diameter.

One of the drawings indicates the method of using the jack block. It is placed under the journal box, the ends spanning



Journal Jack Block with Wheel Clamp

two adjacent ties. The projection on the sliding band is then dropped down against the inside rim of the wheel tread and held in that position by means of a pin placed through one of the 7/16-in. holes in the upright. The wheel is thus clamped against the rail and prevented from lifting as the journal box is raised.

British Locomotive Exports.—There was a slight improvement in British locomotive exports in September, the value of the shipments for the month having been about $1,454,500, as compared with $1,439,590 in September, 1914, and $1,395,525 in September, 1913. The improvement was due to an increase in the value of the deliveries to the Argentine Republic during the month to $118,720, as compared with $34,855 and $274,775. South Africa imported locomotives in September to the value of $189,330, as compared with $64,105 and $133,185, but there was a great falling off in the deliveries to India and Australia.

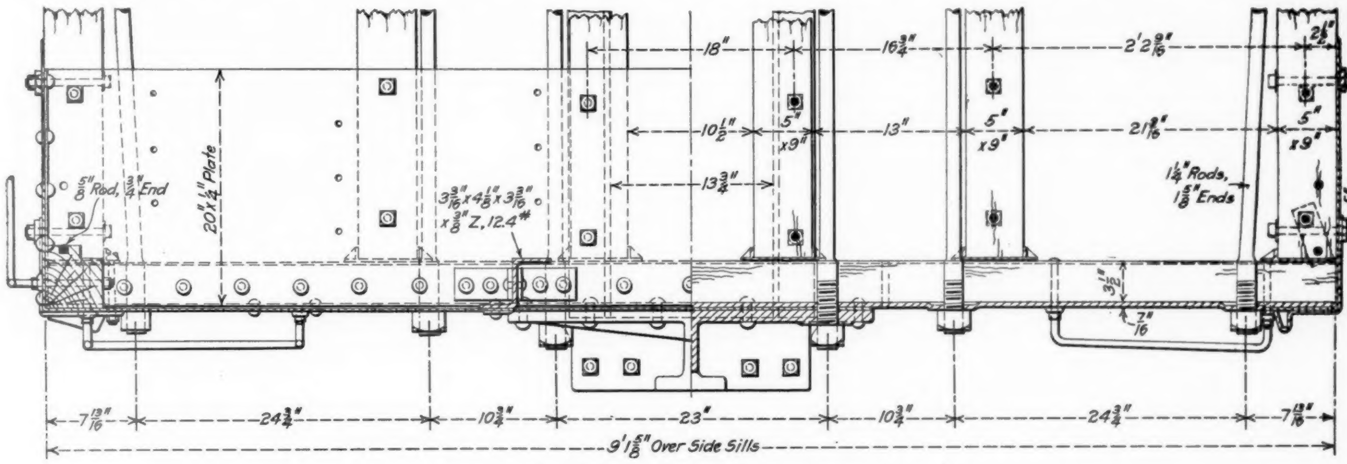
STEEL END BOX CARS FOR THE SANTA FE

Box Cars of 40 Tons Capacity With Interesting Examples of Steel End and Side Door Construction

The Atchison, Topeka & Santa Fe has recently received from the Haskell & Barker Car Company, 700 36-ft. box cars of 80,000 lb. capacity, which include a number of interesting details of construction. These cars have steel ends and the truss rod type of underframe, and weigh 43,300 lb. The following is a list of the general dimensions:

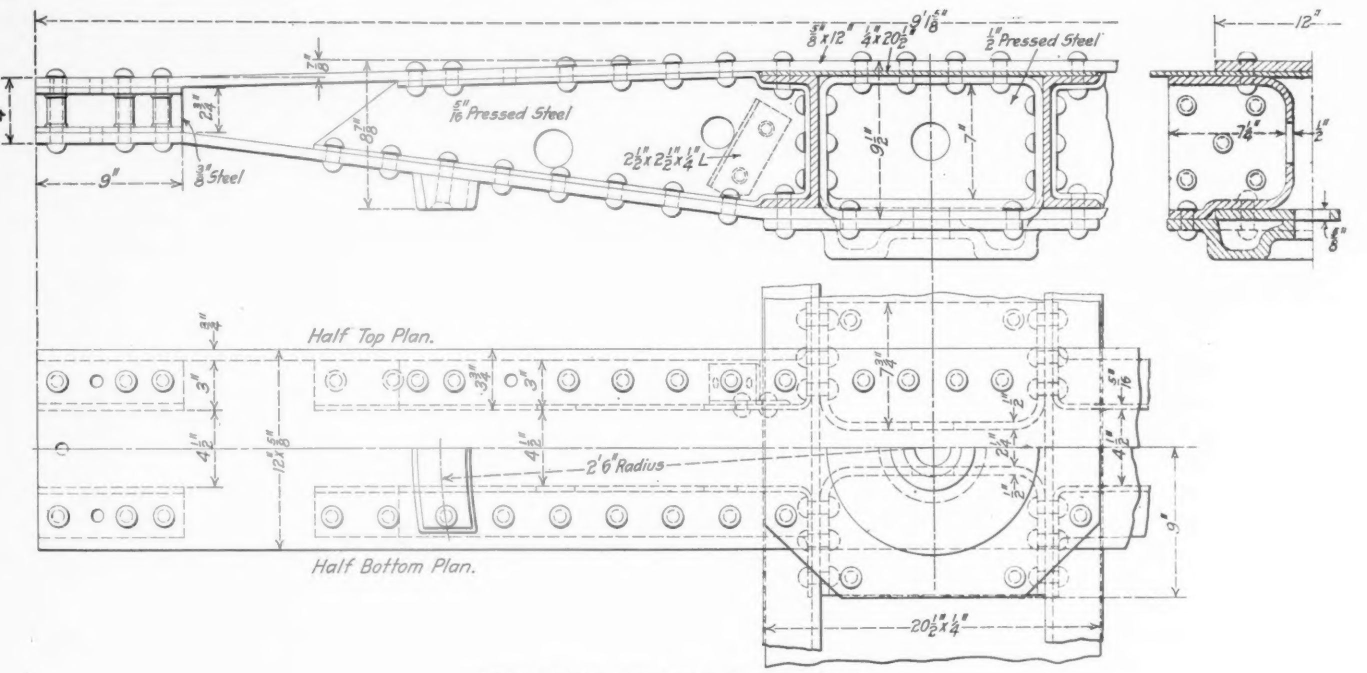
Length over end sills	37 ft.
Length inside	36 ft.
Width over side sills	9 ft. 1⅝ in.
Width over siding	9 ft. 3¼ in.
Width inside	8 ft. 6 in.
Height inside, clear space	7 ft. 11 13/16 in.
Height from top of rail to top of running board	13 ft. 3 7/16 in.
Wheel base of car	32 ft. ¼ in.
Wheel base of truck	5 ft. 4 in.

These cars were built for grain and heavy merchandise service, the ends being of especially substantial construction. The underframe is made up of 5 in. by 9 in. wooden longitudinal sills located 9 in., 2 ft. 1¾ in. and 4 ft. 4 15/16 in. each side of the center line of the car. The two center sills are reinforced with 8 in. ship channels located directly underneath them, which form the draft members of the underframe. The bolt holes in the side sills are located to give the car body a camber of 1 in., which must be maintained with no tension on the truss rods. The truss rods are 1¼ in. in diameter and are located 6 in., 2 ft. 6⅛ in., and 3 ft. 6¼ in. each side of the center line of the car. They pass over chairs on the body bolster and are anchored in the end sills. Cross beams consisting of 8-in., 18-lb. channels are located 4 ft. 3 in. each side of the transverse center line of the car. They



End Sill for Santa Fe Box Cars

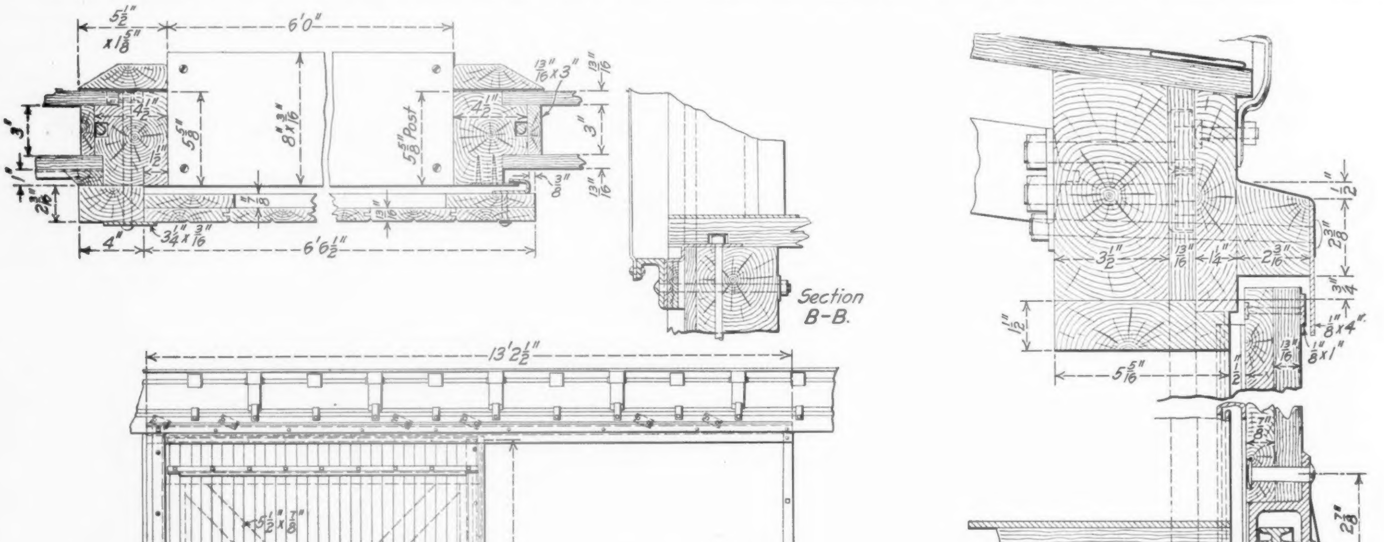
Atchison, Topeka & Santa Fe 40-Ton Steel End Box Car



Body Bolster for Santa Fe Box Cars

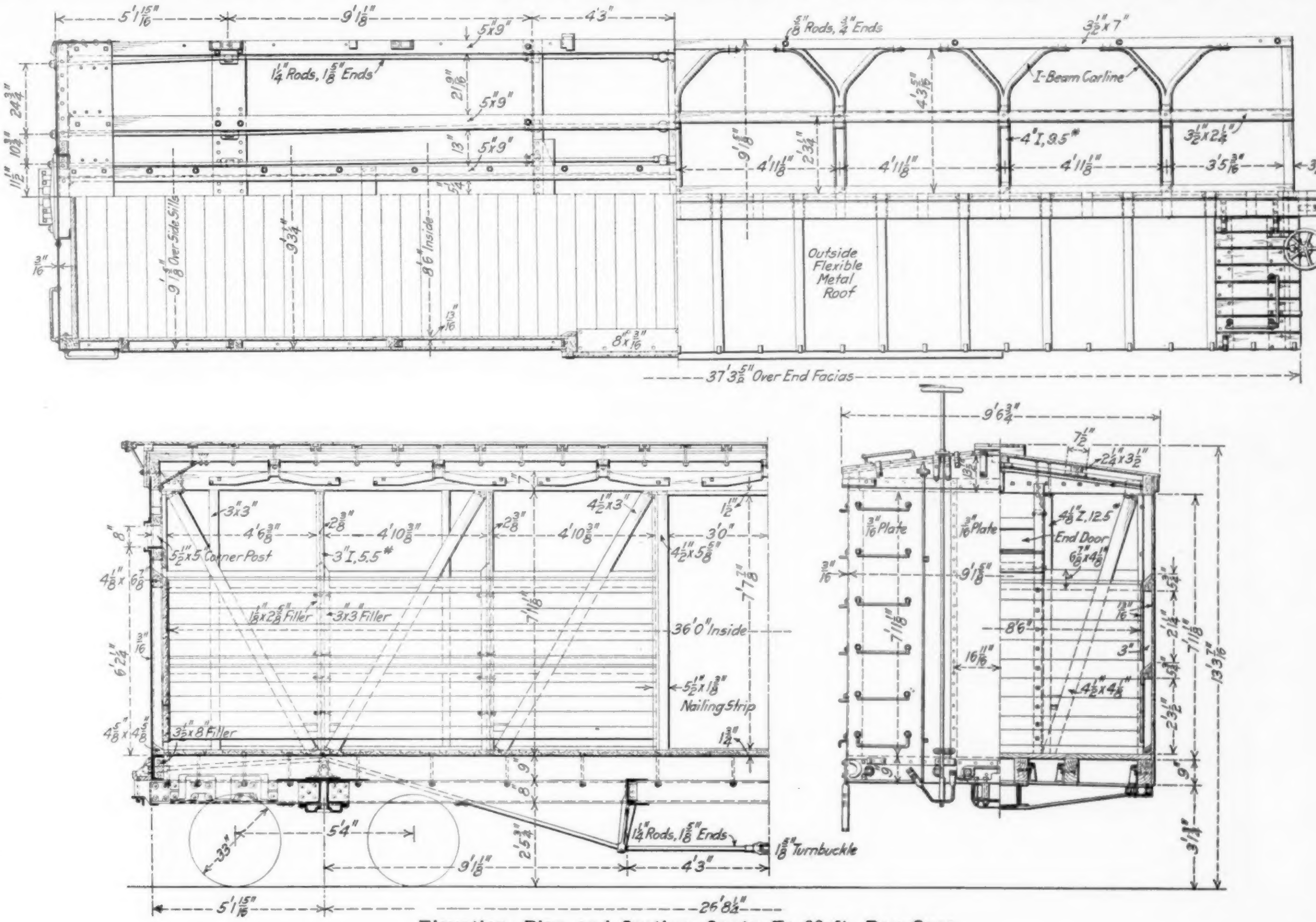
are cut to fit against and between the draft sill channels and are riveted to gusset plates. They are bolted to the side and intermediate sills and support the queen posts for the truss rods.

The body bolsters are located 5 ft. 2 9/16 in. back of the end sills. They are made up of ⅝-in. by 12-in. top and bottom cover plates with two ½-in. pressed steel center fillers, four 5/16-in. pressed steel intermediate fillers and four ⅜-in. end fillers riveted to the cover plates and center draft sills with ¾-in. rivets. The body center plates are drop forgings and the side bearings are located 2 ft. 6 in. each side of the center line, the Standard Car Truck Company's roller truck side bearings being used. The end sills are 9-in., 28.6-lb. ship channels with 3½-in. by 8-in. oak fillers. The channels are pressed to form a bearing for the truss rod nuts.

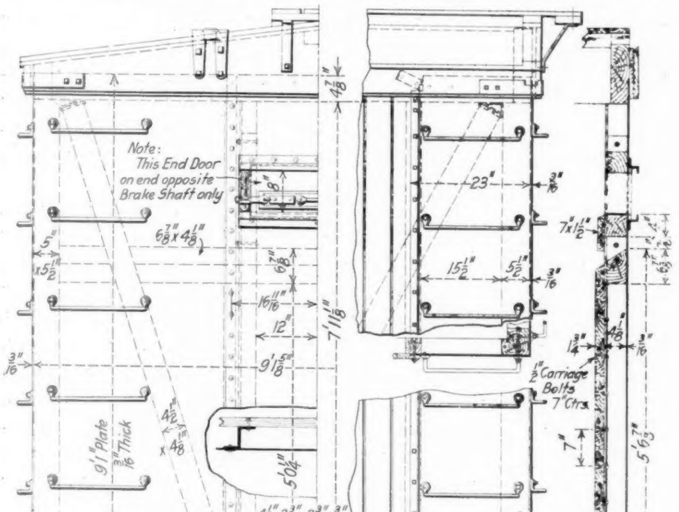


Santa Fe Box Car—Side Door Construction

A unique feature in the design of these cars is the substantial end construction. It consists of two 4⅛-in., 12.5-lb. Z-bar end posts, 3/16-in. outside steel sheathing and a 1¾-in. wood lining inside. The outside steel sheathing is applied vertically in three sections, the two outside plates extending around on the sides of the car for a distance of 23 in. The middle sheet is 33⅜ in. wide. It is offset at the sides to lap over the end sheets and is riveted to the end posts with the end sheets by ½-in. rivets. The side sheets are bolted to the corner posts both at the ends and sides by ½-in. carriage bolts. The ladder irons are fastened to the car by these bolts at one end and are riveted directly to the steel sheets at the other end. The side sheathing is gained out to receive the end of the side sheets and they are both attached to a cripple post by ⅜-in. carriage bolts. At the bottom the steel plates are riveted to the end sill and bolted to the side sills and at the top are fastened to the end and side plates by ½-in. carriage bolts.

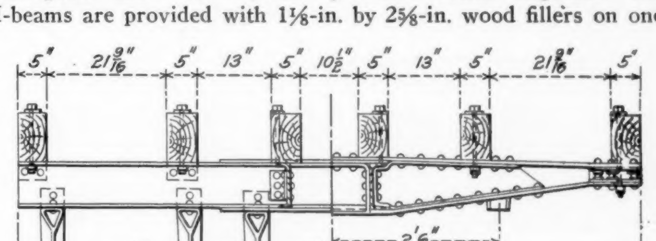


Elevation, Plan and Section, Santa Fe 36-ft. Box Cars



Steel End Construction, Santa Fe Box Cars

The side framing consists of eight 3-in., 5.5-lb. I-beams for side posts and twelve 4½-in. by 3-in. wooden diagonals. The I-beams are provided with 1⅛-in. by 2⅝-in. wood fillers on one side and 3-in. by 3-in. fillers on the other to which is nailed the inside sheathing. The inside sheathing extends only 5 ft. 2 in. above the floor. It is 13/16 in. thick at the sides and 1¾ in. thick at the ends. As will be noted in the section through the framing, an opening is provided just above the lower belt rail and at the floor. This precludes the possibility of grain lodging between the lining and the outside sheathing. There are two


Half-Sections Through the Underframe

belt rails on the side of the car and one at the end. They are beveled on the upper face, as is the grain strip at the bottom, to prevent the grain from lodging on them. Seven 4-in., 9.5-lb. I-beams are used for the carlines. These are bent at the middle and split at the ends, the legs thus formed being spread out and bolted to the side plate as indicated in the plan view of the car. The ridge pole and purlins are bolted directly to the carlines.

The side doors are of particular interest. They operate on bottom rollers, the track being an inverted unsymmetrical U-section the long flange of which is bolted to the side sill with ½-in. carriage bolts. The roller housings have two legs which

Steel End of the Santa Fe 36-ft. Box Car

hook over the short flange of track, the latter serving as the door guide. The top guide is a 4-in. by ⅛-in. steel plate which with a 2 3/16-in. filler block is secured to the side plate by ½-in. carriage bolts. Both the front and back door stops are reinforced with steel plates, and cripple posts are placed directly behind the back stop. The door itself is reinforced with two 1 25/32-in., 2.6-lb. Z-bars, one 7⅜ in. from the top and the other 10½. from the bottom. Security weather strips are applied at the back of the doors. Nailing strips are applied to the inside of the door posts, with burlap between, to which are nailed the grain doors when the car is used in grain service.

These cars are equipped with the Class A-19-C Minor friction draft gear, Andrews cast steel truck side frame, Camel Company's side door fixtures, Standard Railway Equipment Company's outside flexible metal roofs and the Standard Car Truck Company's truck roller side bearings.

AUTOGENOUS WELDING IN BOILER REPAIRS.—Autogenous welding for effecting boiler repairs is convenient in many instances, but its advantages are apt to lead to oversight of the real causes which produce the defects the welding is intended to remedy.—*The Engineer.*

SOME LESSONS FROM EXPERIENCE WITH STEEL FREIGHT CARS

BY MILLARD F. COX
Assistant Superintendent, Machinery, Louisville & Nashville, Louisville, Ky.

FIRST PRIZE ARTICLE*

Since the advent of the all-steel freight car about 15 years ago, it has grown steadily in favor. It has come to stay. Beginning with the all-metal bolster, the use of steel has extended to nearly all parts of the car, including end and center sills, underframe and superstructure. Complete all-steel freight cars are now made in the following types: hoppers, gondolas, flats, box and house, and cabooses. This does not mean that there is no wood used in connection with their manufacture. In some instances, such as the house car, it is necessary and essential to have a wooden lining to protect the lading against the sweating of the steel and for general insulation purposes.

All-steel freight cars are so new that the best information as to their life is subject to modification. Like the modern steel building, it remains for time to get in its work before definite data of practical value can be obtained. There are some things, however, that we are reasonably sure of. All-steel freight cars will stand more hard service and general abuse than the best wooden car ever designed. They may be damaged in a variety of ways, just as other cars are, but seldom beyond recovery.

Steel cars should be painted occasionally, and they require some attention and repairs. All of this combined is considerably less than for the wooden cars, while the cost of maintenance is decreased correspondingly. Experience with all-steel equipment is convincing that the maintenance bugbear is not nearly so formidable as was anticipated.

The high type of hopper gondola car is costly to repair. The entire car must be dismantled in some cases, in order to straighten it properly. The cost for this is considerably more than for the composite car of the same capacity. By composite I mean the steel underframe and wooden superstructure. The steel car is seldom demolished beyond the repair point and while it requires more time and money to put it back into commission, it remains in service longer and takes extraordinary abuse without being destroyed. The design is more substantial and the material is of more lasting quality; therefore, we have a better car. For this we have paid more in the initial cost and have increased the weight somewhat, but have also added greatly to the life of the equipment. The all-steel car is the only kind that can be handled by the unloading machines in use at the Great Lakes and other points.

The deadliest enemy of the steel car is corrosion. We have watched this closely, and our observation shows a wasting of some of the members at various places on coal, refrigerator and ore cars, from 30 per cent to 60 per cent from the original dimensions. In some cases, for short distances, their strength is not only impaired, but almost destroyed. The cars on which we noticed as much as 60 per cent loss have been in service about 14 years. The side and center sills require reinforcing. We find it is cheaper to reinforce in some cases than to cut out the old member. Our engineers may do well to take this into consideration in future calculations in connection with load and buffing shocks.

If it were practicable to paint steel cars as we do bridges and other structural work, their life would be indefinite. If corrosion could be eliminated the fatigue of the metal would be its only limiting factor. Protecting the metal work by cleaning and painting is therefore highly important. Cars should be periodically sand blasted all over, as if they were new and just turned out by the manufacturers. If it were practicable to do this systematically and thoroughly, there is no telling how long a steel car would last. Sand blasting

* Awarded the first prize of $35 in the Steel Freight Car competition which closed December 1, 1915.

the mill scale from new steel plates is essential to obtain the best results from painting.

Theoretically, there are no weak points in a well-designed steel car, but like all equipment of this character, there is a part which will fail if it is hit hard and often enough. Some of the outside and center sills have cracked and been patched with inside and outside riveted cover strips. Some of the center sills are spreading, due to the buffing stresses. This is noticeable, also, on cars of other roads of similar design. Less important members are also showing more or less distress. We find the cutting and welding torches very handy on this class of repairs.

Steel cars may be strengthened by a liberal use of pressed steel shapes in place of rolled ones. These shapes should be kept as nearly to the standard section as possible, and the weight of these details reduced to a safe working minimum.

Rolled shapes have their advantages, but unquestionably increase the weight of the car, one of the things we are endeavoring to minimize. Holding cars awaiting the arrival of special pressed steel parts is a cause for much complaint. This, however, should diminish as the railroads become better equipped for steel repairs.

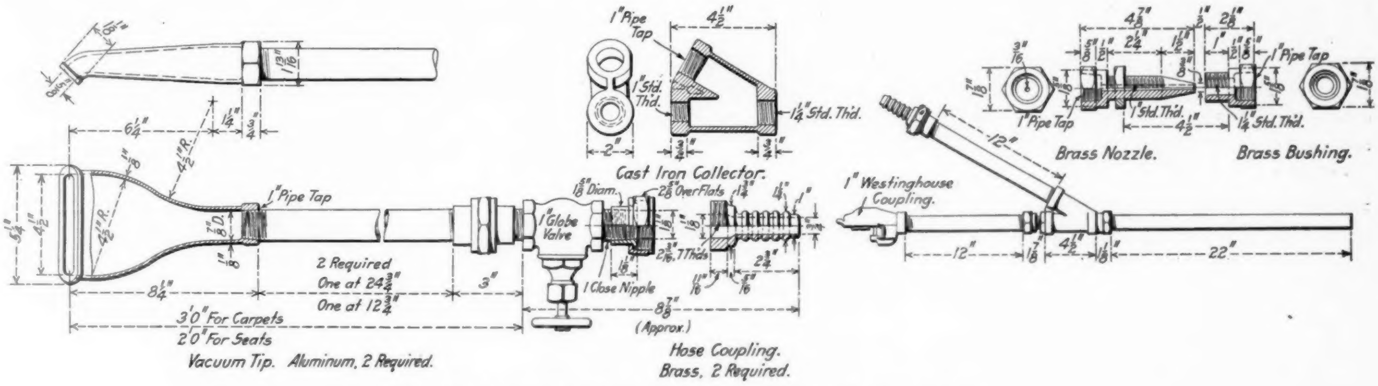
VACUUM CLEANER

The vacuum cleaner, shown in detail in the drawing, was developed by H. J. White, supervisor of car work, Canadian Northern, Eastern lines, for use in cleaning coaches at terminals. Compressed air from the usual service line is used to produce the vacuum.

The essential features of the device are a collector, an ejector nozzle, a vacuum tip and suitable hose and pipe connections to the compressed air line and the vacuum tip. The collector is a special Y-fitting of cast iron, one branch of which is connected to the air supply, and the other to the vacuum tip through a hose of suitable length. The compressed air enters the collector body through a 3/16-in. opening in the special brass nozzle shown in detail in the illustration. In the outlet from the collector is placed a brass bushing with a ¾-in. opening, the inner end of which is located about ½ in. in front of the end of the nozzle.

As the small stream of air issuing from the nozzle passes through the bushing it produces an induced current in the suction branch of the collector, which is connected to the vacuum tip. The air and dust which is thus drawn into the collector is blown out through the delivery pipe.

The vacuum tip is secured to a short section of one inch pipe, which is provided in two lengths, one for cleaning carpets and the other for cleaning seats. In order to facilitate changing the nozzles for the two classes of work, a coupling is placed at the upper end of this pipe. Between this coupling and the hose coupling is placed a 1-inch globe valve, by which the suction line may be closed when changing the nozzles.



Details of Canadian Northern Vacuum Cleaner for Coaches

FOUR-WHEEL TRUCKS FOR PASSENGER CARS

At the annual meeting of the American Society of Mechanical Engineers, held in New York, December 7-10, 1915, was presented a paper by Roy V. Wright on four-wheel trucks for passenger cars. An abstract of the paper appeared in the November issue of the *Railway Age Gazette, Mechanical Edition*, page 569. The paper was discussed by several members, the following being extracts from the more important part of the discussion:

C. D. Young, Pennsylvania Railroad.—The railroads have been too prone in recent years to use six-wheel trucks, based upon their experience with wooden trucks. Due to the flexure in these trucks, it was necessary to go to the six-wheel truck, simply on account of the wheel load. Obviously, as far as cost, and probably maintenance, is concerned, due to the fewer parts, the four-wheel truck is preferable to the six-wheel truck, provided it gives satisfactory service. With the advent of the steel truck, I believe that the total weight of the car which will be satisfactorily carried on the four-wheel truck can be materially increased. The practicability of this is proved by the use of four-wheel trucks under, say, 98 per cent of the heavy passenger locomotive tenders in this country.

Axle loads as high as 45,000 lb. are permitted on passenger tenders, yet when we design a passenger car it is with fear and trembling that we put 31,000 lb. on the same axle.

In order to ascertain what effect on the train's resistance the two extra axles of the six-wheel truck would have we made three round trips each, with a dynamometer car on a ten-car train, using four-wheel trucks, and a ten-car train using six-wheel trucks, the car bodies being the same in both trains. The difference in total weight per car was due entirely to the difference in weight of the trucks, the cars with six-wheel trucks each weighing 66 tons and those with four-wheel trucks weighing 59 tons each. The tests indicated that the only material difference in resistance was due to the difference in weight of the vehicles. With the cars in question we would have the same resistance in 13 cars with six-wheel trucks as would be offered by 14 cars with four-wheel trucks.

The development of the clasp brake outlined in the paper was the result of observation of the clasp brakes used on the Philadelphia & Reading. They were tested in 1912, a complete report of the tests already having been made to the American Society of Mechanical Engineers by S. W. Dudley, of the Westinghouse Air Brake Company.* The single shoe brake had a total weight of 3,682 lb. per car, and the movable parts weighed 3,084 lb. The clasp brake had a total weight of 4,433 lb. per car, the movable parts weighing 2,852 lb., showing an increase in total weight of the clasp brakes of 24 per cent, whereas there is a decrease in the weight of the movable parts of the clasp brakes of 8 per cent. It was developed in our brake tests that it was desirable to have as low weight in the moving parts of the brake rigging

*See *Railway Age Gazette, Mechanical Edition*, for March, 1914, page 136.

as possible, to overcome the effect of inertia, for obviously the heavier the moving parts the more inertia and the longer time it takes to get full braking pressure at the wheel with a given pressure in the cylinder. By reducing the weight of the parts of the clasp brake we therefore have the right to expect that we develop the full braking power slightly quicker than we do on the single-brake car.

At sixty miles an hour, with 125 per cent nominal braking power, the clasp brake car made a stop in the brake shoe tests in 808 feet, which I believe is the shortest stop ever made on a passenger car under that braking power. The corresponding length of stop with single shoes is about 1,250 feet, showing a distinct gain in the length of stop by the use of two shoes per wheel, with an increase in the total weight of the brake rigging of only about 24 per cent.

The use of the clasp brake is economical in brake shoe material. We have recently made a series of road tests of brake shoes, considering the wear under single and clasp brake conditions. On the five different runs on which the test was made the clasp brake shows a saving in brake shoe material of about 30 per cent as compared with the single brake.

S. G. Thomson.—The Philadelphia & Reading has had 100 cars equipped with clasp brakes in service for a number of years. The brake is very highly efficient; the stops with the clasp brake seem to be very much shorter than where the higher pressures are used to get nearly equal braking power.

G. R. Henderson.—It is well known that the Pennsylvania track is nearly perfect and it is a question whether the Pennsylvania four-wheel passenger trucks would give satisfactory service on average track with the loads which they now carry. The abandonment of the equalizers accounts for considerable saving in weight, as the equalizers and spring seats are quite massive for heavy cars. It is still the practice of many roads to use equalizers under tenders of passenger locomotives and also under high speed electric cars, and it is an interesting question as to just how far we can go in abandoning them and still not interfere with the comfort of the passengers. The condition of the track is a very important factor and should not be overlooked when considering this question.

L. R. Pomeroy.—Six-wheel trucks have been developed more generally in the West than in the East and it is only in recent years that their use has become general on ordinary passenger coaches. This refers particularly to passenger coaches, not sleeping cars or diners or heavy weight cars.

Some of the reasons why the six-wheel truck was applied to cars which would be considered quite light today were that from 60-lb. to 70-lb. rails with very light gravel ballast, in some cases nothing but gumbo ballast, were used, and further because of the use of cast-iron wheels. At one time the Chicago, Milwaukee & St. Paul was using cast-iron wheels even on parlor cars, these wheels being considered absolutely safe under six-wheel trucks, but not under four-wheel trucks.

TABLE I.—WEIGHTS OF TYPICAL FOUR-WHEEL AND SIX-WHEEL TRUCKS FOR PASSENGER CARS

Road	Type	Diam. and length of journals Inches	Weight of trucks per car Lbs.
Harriman Lines	Four-wheel	5 x 9	26,500
Western Pacific	Four-wheel	5½x10	31,000
Rock Island Lines	Four-wheel	5 x 9	31,120
Barney & Smith built-up truck	Four-wheel	5 x 9	27,600
Canadian Pacific	Four-wheel	5 x 9	26,400
N. Y. N. H. & H	Four-wheel	5½x10	31,400
Harriman Lines	Six-wheel	5 x 9	42,000
Rock Island Lines	Six-wheel	5 x 9	41,220
Commonwealth Truck	Six-wheel	5 x 9	45,900
Pullman Standard	Six-wheel	5 x 9	42,720
New York Central	Six-wheel	5 x 9	*45,000
Barney & Smith built-up truck	Six-wheel	5 x 9	42,000
C. P. R. 70-ft. diners	Six-wheel	5 x 9	41,200
C. P. R. 72-ft. sleepers	Six-wheel	5 x 9	45,900

*Equipped with clasp brakes.

The following data has been compiled partly from the columns of the *Railway Age Gazette, Mechanical Edition,* and partly from information furnished by the builders. In Table I is shown the weight of typical four-wheel and six-wheel trucks. In Table II the weights of typical examples of recent passenger construction. Most of these cars are carried on six-wheel trucks. Allowing 42,000 lb. per car, where the weights of the latter are not known, and 27,000 lb. per car for four-wheel trucks a comparison is made of the actual total weight of each car with the weight had four-wheel trucks been used.

TABLE II.—WEIGHT OF TYPICAL PASSENGER CARS SHOWING SAVING IN WEIGHT BY THE USE OF FOUR-WHEEL TRUCKS

Road	Class	Construction	Weight with six-wheel trucks lb.	Weight of car body lb.	Weight with four-wheel trucks lb.
Wabash	60-ft. mail	Steel	124,000	82,000	109,000*
N. Y. C.	Coach	Steel	142,000	100,000*	127,000*
N. Y. N. H. & H.	Coach	Steel	131,000	89,000	......
N. Y. N. H. & H.	Coach	Steel	......	90,000	121,400
G. T.	74-ft. coach	Composite	137,000	97,000	124,000*
A. T. & S. F.	Coach	Steel	134,000	91,000	118,000*
A. T. & S. F.	Chair car	Steel	136,000	93,000	120,000*
Jersey Cent.	Coach	Steel	......	81,800	115,800
U. P.	69-ft. bag.	Steel	......	79,000*	106,000
U. P.	60-ft. mail	Steel	......	84,600*	111,600
Long Island	Parlor car	Steel	......	......	124,000

*Weights estimated.

There are many cars running successfully on four-wheel trucks that weigh as high as 124,000 lb. The Long Island parlor car of this weight shown in Table II is carried on four-wheel trucks with 5-in. by 9-in. journals, and the load on the projected journal area is only 344 lb. per sq. in.

Under ordinary conditions of service there is no justification for a six-wheel truck under a suburban car, and yet there are a great number of suburban cars which are running on six-wheel trucks. I will go further. I have never yet seen a 70-ft. car of the ordinary passenger coach type where the six-wheel truck was justified with the track we have today.

The following instance is given because of its bearing upon the difficulty from hot boxes. On a certain railroad, where, from the weight point of view, the 5 in. by 9 in. journal was perfectly satisfactory, and they were maintaining their journals in good shape, they were having trouble from hot boxes. They substituted the next larger M. C. B. axle, and still had trouble from hot boxes. An analysis of the situation brought out the fact that with the new form of high-speed brake the pressure with one shoe per wheel was such that it caused the brass to tilt and prevented the proper contact on the journal. When the clasp brake was applied no trouble was experienced with the 5 in. by 9 in. journal.

S. G. Thomson.—We made some tests on the Atlantic City Railroad to determine the cause of hot boxes in very high speed service, up to 80 or 90 miles an hour on some parts of the road. We took some temperature readings of the boxes and found that the trains would come into the terminal with the boxes almost at the flashing point. In the rush season we had to turn these trains back on the reverse trip at once, and no doubt the accumulated heat in the wheels and journals had something to do with the hot boxes on the way back. We ran these trains sometimes six trips during a day and occasionally the boxes would heat up, without any apparent reason, having had careful attention at both ends of the route on all trips. The cars were all-steel, weighing about 118,000 lb., and in my judgment were about at the limit for the four-wheel truck for that speed. We took the same cars on our New York division, where we have a couple of stops, and do not run at such high speeds, and they gave us no trouble whatever. The speed seems to be a factor in the question of using the four-wheel truck, and when our last cars were designed we considered very seriously the use of six-wheel trucks. We concluded to stick to the four-wheel truck and have done so with fairly good results.

G. W. Rink (C. R. R. of N. J.).—I would like to ask Mr. Thomson whether it was with the type of truck with the springs directly over the journal boxes that the trouble with hot boxes occurred. We had a few cars built with trucks of that type, and eventually went to the one-piece Commonwealth truck, be-

cause of trouble from hot bearings. On the trucks without equalizers, having the coil springs placed directly over the journal boxes, there is a tendency for the boxes to tilt and bind in the pedestal, producing uneven distribution of bearing pressure and wearing the box flanges. These trucks weighed 15,200 lb. each and the Commonwealth trucks, which we now use, weigh 17,000 lb. each. Both types of trucks have clasp brakes, with beams across the truck.

S. G. Thomson.—The trucks tested were not the ones with the springs over the journal boxes, although that type has given more trouble than the other type.

A SUGGESTION FOR COMPOSITE FREIGHT CAR CONSTRUCTION*

The connection between the wood and the steel center sills is of utmost importance in the construction of wood cars with the steel underframes. Many such cars have been hit so hard that the striking castings were driven through the end sills and the underframe completely disconnected from the car body.

The manner of bolting the two together is largely responsible for this result. In all cases the bolts should pass through both flanges of the channel sills. This more than doubles the strength of the bolts and while it takes longer bolts, the difference in cost is well worth while. In the first place, when the bolts are used in the upper flange only, part of the thread is above the channel in the wood sill. Between the two sills is the point where the bolt should be strongest, but the section of the bolt is reduced by the threads, which nick it sufficiently to cause it to break easily at this point. Furthermore the inner face of the flange is rolled at an angle so that the nut bends the bolt as soon as drawn tight. If the bolt be extended through both flanges its strongest point is between the wood and the steel sills and the nut is drawn up on the lower face of the lower flange, which is perpendicular to the center line of the bolt.

THE LIFE OF A STEEL FREIGHT CAR†

BY SAMUEL LYNN
Master Car Builder, Pittsburgh & Lake Erie, Pittsburgh, Pa.

In preparing this paper it was decided to get the opinions of some other car men regarding the life of a steel car and I wrote to several friends who have had considerable experience with such cars. Their replies showed that there is quite a diversity of opinion and that a steel car will last anywhere from eight to fifty years.

Years ago while working on the shop tracks repairing the old wooden cars, I can remember distinctly seeing an occasional train of steel cars, or "battleships" as we called them, go by; the repairmen would get together and discuss the question of where they would get their bread and butter when the old wood car finally went to the scrap pile. There are some car department officers at even this late day who apparently feel that the steel car does not require much attention. However, this theory is no longer given much consideration, as any one responsible for steel car maintenance realizes that while the steel car, with its larger carrying capacity, increases the earnings of a road, after the car reaches a certain age its maintenance cost increases over that of the old wooden car. As a consequence there are several things that must be considered when discussing this subject.

First.—It seems to me that the problem of most importance is the design of the car. Care must be taken to get the required strength in the underframe in order that the car may withstand the shocks incident to present-day transportation. In addition to a good solid underframe, the draft sills and draft gear must be equally strong to stand up to their work. I have seen new cars turned out of a car plant and after the first or second loading the draft sills, or center sills extending from the end sill to the front of the body bolster, were so badly buckled that they had to be removed and replaced and reinforcement added to strengthen the weak members; and these cars, although practically new, were useless until the parts mentioned had been reinforcd to take care of either oversight or poor judgment in the drafting room. Consequently, too much stress cannot be laid on proper design.

Second.—The commodities with which a car is loaded and the climatic conditions in the territory through which it travels are important factors in the life of a steel car. The cars in this territory used exclusively in the coal, coke and ore trade are subject to very severe service, as they are usually hauled in heavy tonnage trains, and the acids in the coal and coke eat through the floor sheets rapidly. In addition to the injurious effects of the acids on the inside of the car, the varying weather conditions—rain, snow and heavy damp atmosphere—play important parts in the deterioration of the car.

As previously stated, at one time a number of car department officers were of the opinion that the steel car required but little attention, and as a result in its early existence even the car inspectors would look over the car primarily for safety appliance defects, hot boxes, etc., and take it for granted that because the car was of steel construction it was all right. For some reason, the steel car from the time it first went into service did not seem to have a friend. At the industrial plants where the cars were unloaded the men took frequent cracks at them with sledges and as a result the side and hopper sheets soon became bent and distorted. During the winter season when ore became frozen in the cars, some of the plants used dynamite to loosen it up and in addition they frequently loosened up the floor and side sheets at the rivets. If the steel car was given reasonable treatment and repairs made when needed, and repainted when the steel became exposed to the weather, the renewing of some of the parts would not become necessary for a longer period than is now the case.

The original painting of the steel car is usually faulty. Owing to the hurry-up methods of the building the required quality of paint is liable to be dryer-sacrificed, or made to fit the building time of the car, without giving the protective qualities of the paint due consideration. I do not want to be understood as saying that paint will cure all the ills of the steel car, but do believe that if a liberal quantity of good paint was used to protect all outside exposed parts, the life of the car would be lengthened considerably. Occasionally we may hear some railway officer use the expression that "a steel car will run and earn just as much money without paint." This may be true, but the question is, how long will it run? I firmly believe that part of the expense necessary on steel equipment today is due to paint neglect. I do not favor painting the inside parts of any steel car—the first loading would cut and mar the paint so that moisture would get under it—but by keeping the outside exposed parts painted, the corrosion of the outside parts of the sheets would be counteracted to a considerable extent.

On hopper cars it has been found that after the first 10 or 12 years' service the floor and hopper sheets deteriorate from ¼ in. in thickness to a very light gage. In fact, along the seams and sides of the cars where the floor sheets are riveted to the sides, in some cases the steel is completely eaten or rusted through, and in order to get any further service from the car it is necessary to renew the floors and hoppers. This has been done on a large number of steel hopper cars at an approximate cost of $225 a car. After this class of repairs is completed and the cars have been in service for about four years we find that the car sides which were in fairly good condition when the new floors were applied have deteriorated to such an extent that it is necessary to renew the sides of the cars. This work can be done at an approximate cost of $130 a car, making a total expense of $355 a car on the car body, exclusive of various light repairs necessary at different times.

While this class of repairs are being made it is found in

* From a paper by H. C. Priebe, read before the Car Foremen's Association of Chicago, December 13, 1915.

† Abstract of a paper presented at the December meeting of the Railway Club of Pittsburgh.

a few cases that the center sills have deteriorated to some extent from corrosion. They may also have buckled, making the application of new sills necessary. Where new sills are applied on such cars there is an additional cost of $45, making the total amount spent on the car body approximately $400. However, on a very large percentage of the cars on which this class of repairs is being made we do not find it necessary to renew the center sills. These sills, in most cases, have been reinforced between the body bolsters and the hopper sheets by a tie plate or channel section riveted to the sills, the cost of this application being included in the estimates already given.

From the above it would seem that the bodies of the majority of the first steel cars built, or cars that have been in service 16 or 17 years, will require repairs amounting practically to the rebuilding of the car body. This rebuilding process, however, occurs at different periods, whereas if all the parts of any unit of equipment deteriorated at the same rate, there would be no question but that the average depreciation could be fixed very closely, as every part of the unit would become worn out at the same time and the whole body of the car would therefore probably be scrapped or rebuilt as a new unit. The present policy of maintaining the steel car as different parts fail is practically the same method as was employed in the maintenance of the wooden car equipment.

It has been the custom of car department officers to estimate the life of the wooden car of either the box or gondola type at 20 years. The old wooden car, during the 20 year period, received at different times repairs such as two or more longitudinal sills, the renewal of the top side plate, new floors, and other repairs which amounted practically to the rebuilding of the car, yet for general purposes 20 years was considered the average life of the wooden car.

Allowing the same treatment for a steel car, that is, giving it general repairs when necessary and properly maintaining the car so as to get maximum service from it, the steel car is still in serviceable condition after it has run 16 or 17 years.

Some mechanical department officers take the position that it is more economical to prolong the life of the car by repairs, while others say it is better, from an economical standpoint, to run the car until it requires repairs such as have already been described as necessary for the car after it has been in service about 12 years, and then scrap the body and place a new body on the trucks. They take the position that when the floors and hoppers are worn out, the balance of the car has deteriorated to such an extent that it is cheaper to scrap the body than to try to maintain it.

The first metal car purchased by the Pittsburgh & Lake Erie has been in continuous service since June, 1897, except for short periods when it was in the shop for class repairs, and is therefore over 18 years old. It is an 80,000 lb. capacity car of the hopper type; has a cubical capacity of 1,286 cubic feet; weight new 35,700 lb.; weight last time weighed in June of this year, 35,200 lb. The car was built of wrought iron by the Youngstown Bridge Company and is in good condition today. The original sills, bolsters, end sills and draft members, as well as the sides, are still on the car. It received heavy repairs in the years 1912 and 1915 at an approximate total cost of $450. After a close inspection of the photograph I do not believe there is any one present who will say that the appearance of this car indicates that it should go to the scrap pile.

F. W. Dickinson, master car builder of the Bessemer and Lake Erie, advises that their first steel cars, over 19 years old, are in almost as good condition as when first built. The Bessemer and Lake Erie is one of the pioneers in the steel car game, yet Mr. Dickinson advises it is practically impossible for him to make any definite statement as to the probable life of a steel car.

There is one other reason why we should refrain from placing a limit on the life of the steel car, and that is, the steel that is now being purchased and used for repair parts is inferior to the steel that went into the first cars built. While I am not a steel man and know nothing about the business, the fact remains that the steel plates that are being purchased and used for repairs are deteriorating much faster than the original sheets placed on the cars. Whether this is due to the composition of the metal, or to some other cause, I do not know. If this same grade of steel is being used by car builders today on new equipment, and an estimated average life was placed on cars based on the lasting qualities of the material used when steel cars were first built, the steel in the cars that are being built and turned into service today might not last more than one-half the time of the steel in the cars first built, and it is therefore my opinion that we would be doing the steel car an injustice to say that at the end of any stated period it should be relegated to the scrap pile. I believe that the steel car can be maintained as long as the owner desires to run that particular type of car.

INSPECTING CAST IRON WHEELS UNDER FREIGHT EQUIPMENT*

BY J. P. YAEGER
Wheel Inspector, Lehigh Valley

Wheels are guaranteed by the manufacturer for a certain life under fair usage. If they fail to make this guarantee, and have defects for which the manufacturer is responsible, such as worn hollow, worn through chill, seams, shelled out or cracked plates, they are preserved after being pressed off the axle, and at the expiration of the month the manufacturer is given notice; a joint inspection is then made by a representative of the foundry and the wheel inspector to determine what wheels will be replaced. The gentlemen from the foundries are usually "from Missouri;" they want to be shown, and it has sometimes been necessary to put the wheel under the hammer to convince them of the true conditions. This is said with all due respect to the foundry people and simply to emphasize the importance of holding only such wheels as have manufacturer's defects.

YARD INSPECTION

When cars are received at an inspection point the car inspector should make a careful examination for wheel failures, confining himself to M C B Rules 68 to 83. He should also be familiar with the serious results that arise due to wheel defects if allowed to run.

Worn Flanges.—The flange directs the truck, and therefore one flange or the other is in almost constant contact with the rail and subject to friction or grinding under considerable pressure. This is especially true when traversing a curve; the continuous grind in the absence of lubrication results in flange wear. Worn flanges are the cause of many derailments in the yard. If the point of the switch is worn, or there is a slight opening at the point, between the two—the worn flange and switch point—a dangerous combination is formed, and the wheel, owing to its worn condition, mounts or splits the point, and the result is a costly derailment.

Broken Flanges.—These are mostly due to seams which develop below the surface of the metal. They cannot be detected until the surface metal is broken through. I have usually found this defect to exist on wheels under the heavier class of equipment; when striking a curve about two-thirds of the flange breaks off. It is my understanding that when the iron is poured into the mould it first fills the lower part of the hub, then travels through the bottom plate and brackets, filling up the flange. The section of the mould forming the flange is thin and the upper part is formed by the metal chiller. It will be readily seen that the metal in the flange will be cooled somewhat by passing over the cold sand of the mould and coming in contact with the chiller. The more rapid cooling and contraction of the metal in the flange, as compared with that of the tread, tends to cause a separation or seam. As previously explained, this is an inherent defect and develops much quicker on the higher capacity cars, for the reason

* From a paper read at the August, 1915, meeting of the Niagara Frontier Car Men's Association.

that, contour and conditions being alike, the friction due to the increased load brings it about sooner.

Wheels Slid Flat.—It is an easy matter to distinguish this defect from worn through chill by observing the fine hair lines which are caused by the separation of the chill due to the friction between the wheel and the rail. This is a delivering company's defect and must be charged on a defect card when received from a connecting line, or the charge must be absorbed as a "no-bill" when occurring on the handling line.

Wheels Worn Hollow.—The amount of wheel wear on the tread to warrant its removal from service is left largely to the judgment of the inspector. A good interpretation of M C B Rule 76 should provide for wheels being removed when worn sufficiently to permit the rim to project far enough below the top of the rail to render it liable to breakage when passing over frogs or crossings, or when the flange becomes so high that the apex is likely to strike the bottom of flange-ways. It is the practice in track work to allow a minimum of 5/8 in. for flange clearance at the bottom of flange-ways in frogs, crossings and guard rails. This allows the tread to wear down 5/8 in. before the flange strikes the frog and crossing filler. The minimum amount a wheel shall be worn hollow is not specified, but is generally conceded to be 3/16 in. In the Master Car Builders' proceedings for 1905 it was recommended that wheels be allowed to wear down 3/8 in. before condemning them, unless worn through chill. Wheels of the ordinary taper can become worn 3/8 in. from the original contour at the throat before they become worn 3/16 in. hollow on the tread.

Brake Burn.—In brake-burnt wheels the tread is broken up into fine hair lines running parallel across the tread of the wheel, generally covering a considerable portion of the circumference; if kept in service, the continuous pounding causes the metal to drop out little by little, resulting in a comby condition of the wheel tread.

Shelled Out.—This refers to spots where the metal has dropped from the tread in such a way that a raised spot is left in the center with a cavity more or less circular around it.

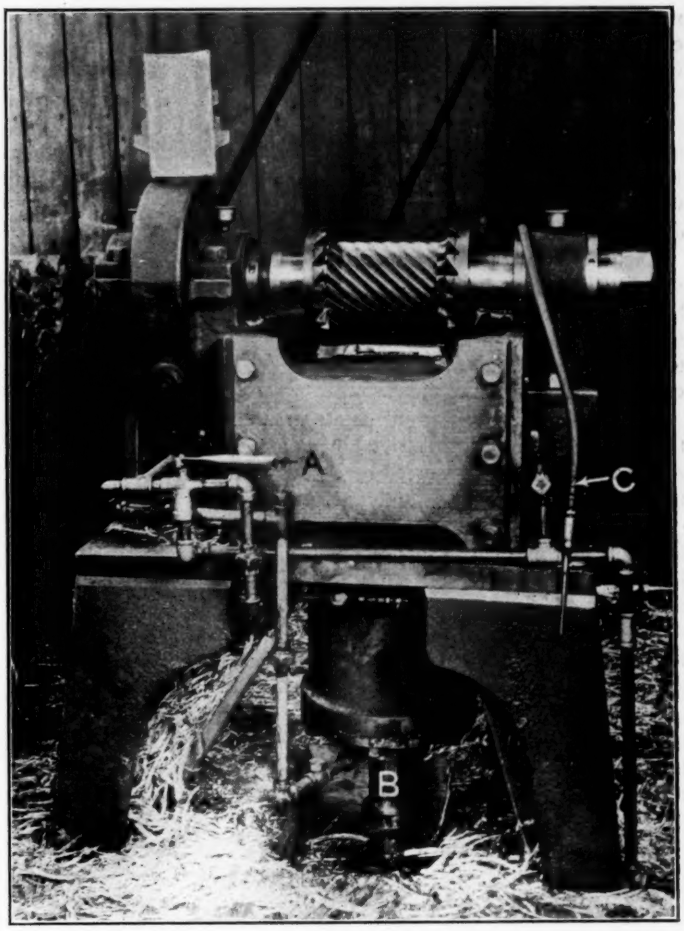
Broken Rims.—These are usually due to wheel being worn hollow or having seams or hollow rims.

Worn Through Chill.—This is a manufacturer's defect and can often be discerned by the appearance of the tread and the manner in which it is worn. If worn irregularly, *i.e.,* deeper at some places than at others, or if worn flat, it is evident that the chill is destroyed. By breaking the flange at a point where the wheel is worn it is an easy matter to determine the amount of chill left in the wheel. If the wheel was slid it would make itself apparent by discoloration of the chill.

It must be understood that the maintenance of wheels involves a large amount of money, and an over-zealous inspector can divert to the scrap heap many wheels that have not outlived their usefulness. It therefore behooves each one of us to use his gage with discretion, so that each wheel may perform its proper duty in the mileage that is expected of it.

FINISHING CAR JOURNAL BRASSES

In order to provide a smooth bearing on new re-babbitted car journal brasses and thereby eliminate the heating of the journals when new brasses are first applied, the Great Northern has in service at the Dale street (St. Paul) shops the belt-driven milling machine, shown in the accompanying illustration. The milling cutter finishes the face of the bearing and rounds off each end to the proper radius. The brass is held in jaws operated on the toggle joint principle and is forced into the milling cutter by the air-operated plunger shown under the machine. The method of operation is as follows: The brass is placed in the jaws of the machine and the air pressure is applied by turning the handle *A* to the left. The plunger *B* is then raised, closing the jaws tightly onto the brass and at the same time moving them with the brass upward and onto the milling cutter. A special clutch is also provided, which throws the milling cutter into action as soon as the air is applied to the plunger. The air pipe *C* with a push button valve is used to blow away



Milling Machine Used in Finishing the Bearing Surfaces of Journal Brasses

the babbitt shavings after each operation. A finished brass is shown on top of the gear box at the left. This machine was made at the company's shops from scrap material.

MAKING EFFICIENT CAR INSPECTORS*

BY HARVEY DE WITT WOLCOMB

The car inspector's relationship to a railroad is the same as a traffic policeman's relationship to a large city. Their duties, though widely separated, have several features in common. The car inspector works under far more dangerous conditions and his surroundings are not as pleasant as the traffic policeman's, yet he should perform his duties with the same thoughtfulness and painstaking care as if he were stationed on one of the most prominent streets of any large city.

To secure faithful and loyal service under the most trying conditions is a sure indication that the training has been along the right lines and the cost of this kind of training soon repays the investment; the first step to be considered in the selection of a future car inspector is not his training, but his qualifications, for some men receive the very best of training, yet fail when it is put up to them to properly apply the many rules and regulations they have been taught, or how to handle themselves when placed on their own resources. In order to avoid wasting time and money on this kind of a man, prospective car inspectors should be examined to see if they have the "foundation" to build on.

The very first point to be settled is whether the man is physi-

* Entered in the Car Inspector's Competition, which closed October 1, 1915. For prize article see November issue, page 575. See also December issue, pages 624, 627 and 628.

cally perfect, or in other words, has he a constitution strong enough to stand working outdoors in all kinds of weather and to stand the sudden changes of weather without complaint, for car work must be handled in all sorts of weather and train schedules must be strictly adhered to. This question can be easily answered by an examining physician. The next question is whether the man is regular in his habits. Is he reliable, for when a man promises to come to work at 7 a. m. and does not report until near 8 a. m., he is not reliable; one of the most important requirements of a good inspector is his reliability. In fact, the railroad depends on the inspector's word in the same way as we depend upon the word of the president or cashier of a bank.

The foreman selecting a man to be trained for a car inspector should know that he is of the observing type and will not lose his head in exciting times. Observation plays an important part in the success of an inspector, and while it may not be developed to a great extent at first, it will be developed by actual experience.

The last two qualifications are easy to investigate and while they seem insignificant, if not noted before training a man, the entire training may be wasted by either one of these traits. They are the man's home life and hobbies. Several large industrial organizations have found it beneficial to investigate the home life of their employees and in the case of a car inspector, I believe it is an absolute requirement. We cannot expect much in the way of study from a man who never remains home nights, but who is out late attending "lodge" or some other social function. Such a man will not have time to study his rule book and besides his rest is broken so that he will not be physically able to concentrate his mind on his work. If a man does not have time to read the papers at home evenings, it is a safe bet that he will neglect his work the next day to get enough time to read at least the baseball news. Home life has a lot to do with the success of any job.

"Hobbies" have spoiled many a man's chances. It is only necessary to talk to a man a few minutes to find out if his mind is on one thing only, or if he is broad enough to see some good in all things. You may say that you would expect your car inspector to have one "hobby," and that is "car inspection," yet it is possible to have this overdone as an athlete sometimes overtrains. My interpretation of the word "hobby" may be peculiar; I mean, for instance, do not place a German and Englishman together inspecting cars and then wonder why they neglect their work to talk war. Try to carry on a conversation with a traffic policeman when he is in the center of a busy thoroughfare and note the answers you get. He will be civil and polite but will soon turn you away, for his mind must be on his work and, if his attention is attracted otherwise, traffic will soon become blocked. Your car inspector should be the same.

TRAINING

Training should start in the office work, for we demand accurate reports from our inspectors, and I do not believe any man realizes the importance of making good, neat and accurate reports until he has tried to handle office work. Very often important law suits depend on the word or record of a car inspector and unless he shows he understands what a record is or how it should be kept, his word is useless. I have known inspectors to keep a book record of the days it rained, or the date of the first snow fall, or some other such common, every day happenings. Then again, office work develops what records to keep and how to keep them as briefly as possible. Keeping note or book records can be overdone by trying to keep a record of too much, and office training is invaluable to get a man started right in this respect.

Following office training, the man should be given a careful course in observation, for on observation depends the success of good inspection. A head inspector whose duties should consist of instruction only, should get in touch with every inspector and talk with him about his work. Today we find that men who are supposed to go over a railroad and instruct the different inspectors, imagine the success of their jobs depends on how many foremen or inspectors they can "write up" for little things that get by them. To my mind, the ideal chief inspector is a man who seldom writes letters and then of praise only, yet can point to the good inspection that is being carried out by the men on his road.

Aim to keep your inspectors satisfied, for it is well known that a satisfied man will do far more work than one who has a grievance. The lot of a car inspector is bad enough at the best and we should watch to better the conditions wherever we can. Inspectors should be sent on little trips to other points to see the conditions under which other men have to work. If the conditions at other points are better than their own, then it will act as an inducement for them to "tidy" up or make a just request to have some conditions corrected. If on the other hand, they find conditions much worse than at their own place of work, they will return with a greater appreciation for their home and be more satisfied.

The heads of the departments should keep in touch with the inspectors by getting out in the car yards and meeting them "as man to man." Imagine how pleased an inspector would be to have "the Old Man" come down to the car yard and thank him for a nice report or good inspection record. Do you know of any more profitable time spent than a little "heart-to-heart" talk by the superintendent of the car department with a number of inspectors, letting them know that by their close attention and good work the company had saved money—that the average wreck cost so much money and that as there had not been any wrecks in the past year, approximately so much money had been saved. Write a nice little article of praise and publish it in the company's magazine or in the town paper, for any man likes to see his name in print, particularly if it is the result of his good work.

Offer cash prizes for good work, or for some specified results, for as a rule the car inspector's pay is not very liberal and if he can increase his earnings by closer attention, he is bound to do so. As a grand prize, offer to take the inspector to the Master Car Builder's convention if he meets certain requirements. Every car inspector in the United States would like to attend one of these conventions and see for themselves just how the car rules are gotten up.

As to the correct use of the many rules that govern car work, it is a sure bet that the inspector cannot repeat the rules, word for word, but he should be examined occasionally to keep him from getting rusty. I know of a certain head inspector that will sometimes go to one of his inspectors and ask his advice about a certain question that has come up. The head inspector will act as if he was "floored" and needed advice. The chances are that the inspector will get so interested that he will not stop at this one case but will study his rule book from the front to the last page.

As to working conditions, the car inspector is a human being and can be coaxed better than driven. You cannot ask a man to walk three miles down through a car yard and then expect him to give you high efficiency. He has wasted a lot of energy in the walk that should be put into his work; it is a good thing to see that the inspector is taken to and from his work, when such arrangements can be made at a nominal cost. You do not expect to get the full rating from a locomotive when the steam pressure is only half of what it should be, so do not expect your inspector to use half his energy to overcome some unnecessary disadvantage and still give you perfect efficiency.

Car yards should be kept clean so that inspectors will not be liable to trip and fall. The inspector's mind should be concentrated on his work. Avoid having him climb up or on cars, for when he starts to climb his mind is taken off his work and he loses the benefit of his previous close attention. Furnish him with car construction books and good reading on his work, so that if he has any idle moments he can put in the time to good advantage.

SHOP PRACTICE

EFFICIENT RECLAMATION OF BOLTS AND NUTS

BY E. T. SPIDY
Assistant General Foreman, Canadian Pacific, Winnipeg, Man.

No material is more generally used in the maintenance of railway equipment than bolts, nuts and washers. The annual expenditure for these commodities is very large and the question of scrap reclamation is an important one. The Canadian Pacific has maintained a reclamation plant at the Winnipeg shops for several years, and this plant has always shown itself to be a paying proposition. In order to increase the output of the plant, however, a careful study of its operation was recently made, with a view to improving conditions without a large money expenditure.

Exterior View of the Nut Storage Bins Showing Additional Storage Capacity Below the Main Bins

The following is a complete analysis of the essential operations in the process of reclamation:

BOLTS

Collected from various sources
Sent to the reclaiming plant
Sorted for length and size
Cut to serviceable lengths
Straightened
Threaded
Delivered to stores or shop.

NUTS

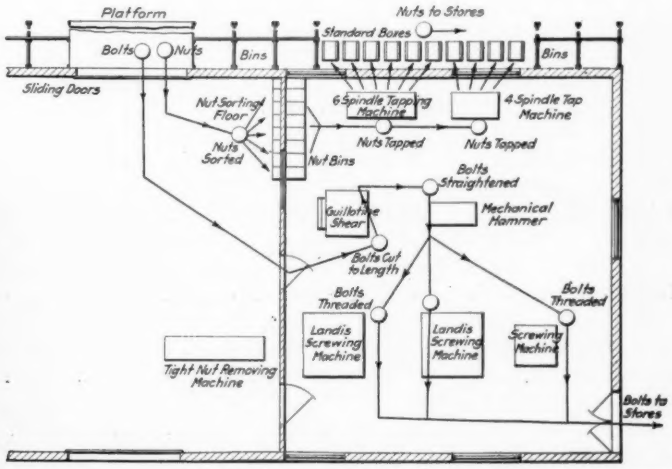
Collected from various sources
Sent to the reclaiming plant
Sorted for size
Retapped
Delivered to stores or shop.

WASHERS

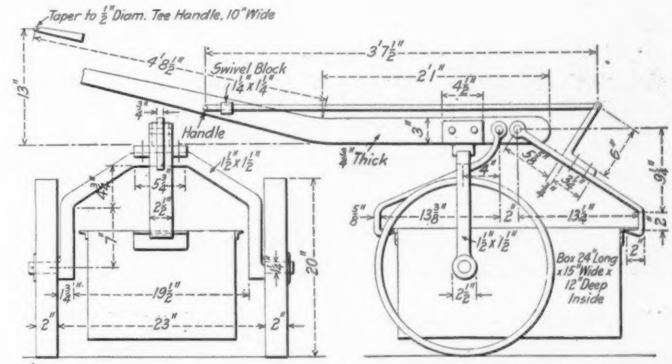
Collected from various sources
Sent to the reclaiming plant
Cleaned
Delivered to stores or shop.

These operations divide themselves into two groups—machine operations and handling. The machine costs are usually well known and may be determined without difficulty. The cost of handling, however, is always more or less indefinite and is much less readily determined, since there are so many variable conditions effecting the efficiency of handling. The investigation was, therefore, largely devoted to the latter phase of the problem. An important factor in the cost of handling is the location of the plant. This did not enter into consideration in the present instance, however, because the plant was already located in a building adjoining the main scrap dock, a very convenient location.

The handling of material such as bolts and nuts is a matter of especial importance, because of the small size and comparatively small value of the pieces, each of which must be handled separately in some of the operation. If handled more than once to complete a single operation, the total cost of reclamation may be considerably increased. The following system was developed in order to eliminate all unnecessary handling and as far as possible to handle the material in quantities. The entire system is based upon the use of a so-called standard box. This box is built up of 3/16-in. plate with 1-in. by 1-in. angle irons at the top. The box is 24 in. long by 15 in. wide by 12 in. deep, and is moved about the shop by means of a special truck shown in one of the drawings. The truck is so designed that one man can readily lift and handle a load of 600 lb., which is about the average load of bolts or nuts handled. All movements of material through the plant are made in these boxes with the special truck which is so constructed that it may be wheeled over a loaded box and the hooks dropped over short angles riveted to each end of the box for that purpose. The hooks are controlled by a rod, the handle of which is placed near the handle of the truck. The box is then lifted by pulling down the handle to a position convenient for pushing the truck. In this position the weight of



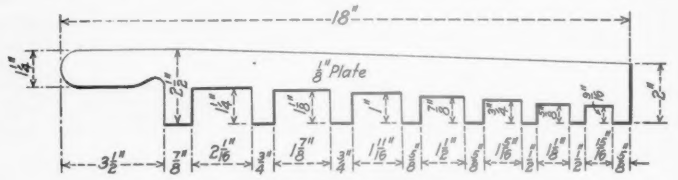
Arrangement of Canadian Pacific Bolt and Nut Reclamation Plant



Special Truck for Movement of Material in Standard Boxes

the box is balanced, the bottom clearing the floor by about two inches.

The location of the machines and the routing of the material from the time it is received for sorting until it is delivered to the stores is shown on the plan of the shop. Bolts are received on the track adjacent to the platform. They are sorted in the car, or at the door of the car, each size being handled directly into a standard box, to be dumped into one of the bins shown against the outside of the building. The sorted bolts are stored in these bins until such time as they are required in the shop. The location of the bins is such that the distance to be traveled when taking bolts into the shop is reduced to a minimum. With the single handling thus required, two laborers are able to do all the sorting.



Gage for Sorting Nuts.

As required, bolts from the bins are taken in standard boxes to the bolt chopper in the shop. The operator of this machine takes the bolts from one box, cuts them to the lengths required, and places them in another box on the other side of the machine. When filled this box is moved by the trucker to the straightening hammer. This is a light machine capable of striking a 75-lb. blow. With this machine one man can supply three triple-head treading machines, whereas with the hand hammer method of straightening, one man was required for each machine. From the straightening hammer the boxes are moved to the threading machine where they are taken from one box directly into another, as previously described.

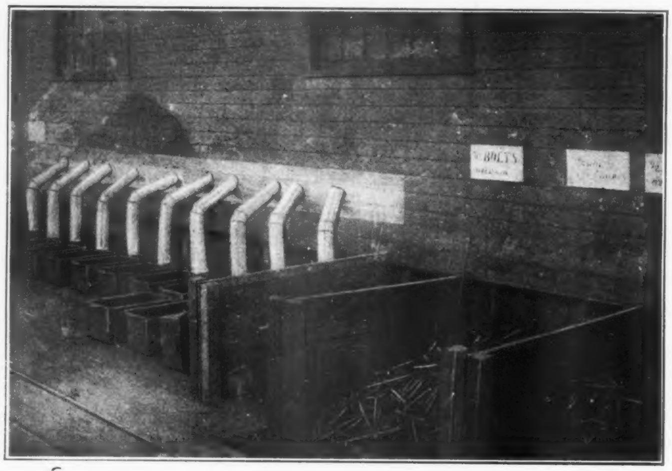
When threaded, the bolts are near the delivery door of the shop, through which they are moved to the storehouse. On


View of the Nut Storage Bins from the Interior of the Shop

reaching the storehouse the bolts remain in the boxes until they can be placed in the storehouse racks. It will be seen that the material is moved forward throughout the process of reclamation, and the only direct handling is that which is absolutely necessary in sorting, placing the bolts in the machines, and finally placing them in the store racks. All other movements are made in bulk.

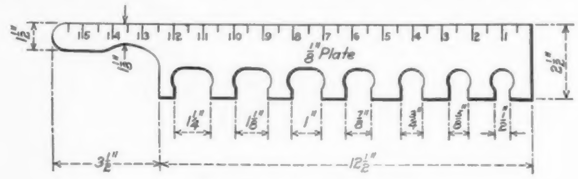
The system of handling nuts is generally similar to that of handling bolts, although some of the details are necessarily different. The nuts are received in the shop building for sorting, special sorting bins being built into the wall separating the machine shop from the remainder of the building. These bins are clearly shown in one of the photographs and are located near the tapping machines. The nuts are sorted outside the shop and thrown into the proper bins, from which they may be removed within the shop as required.

Many nuts are scrapped which cannot be removed from the bolts because of jammed thread or rust. On the scrap platform


Delivery Chutes from the Nut Tapping Machines

and at the freight car shops, the two principal sources of supply, air operated shears are maintained for the purpose of cutting off the ends of such bolts. These bolt ends, which are left as long as possible, are taken to the tight nut removing machine. This was built from an old 20-in. lathe on which a special chuck had been placed to facilitate the removal of tight nuts.

The practice of allowing a tapping machine operator to be surrounded by many boxes of nuts which he removes in handsful to the machine table has been eliminated. Each operator is provided with a bucket holding about 100 lb. of nuts. This quantity he draws from the bins as required, emptying them into the small table bins which hold about 100 lb. per spindle. As the nuts are tapped they mount the spindle. They are removed from the spindles by the operator and allowed to slide off the tap down chutes at the back of the machine. These chutes pass through the outside of the building, each delivering into a stand-



Bolt Sorting Gage.

ard box. When the boxes are full a laborer replaces them with empty ones, and the full boxes are then taken to the storehouse or delivered to the shops.

Washers are received at the scrap dock in considerable quantities. They are sorted to size directly into a row of standard boxes, to be cleaned in a rattler and further sorted according to condition. New washers are made from old tubes rolled flat as well as from other scrap material, and are always cleaned in the rattler to remove rust.

The use of the special truck and standard boxes is almost unlimited. In our bolt plant all newly manufactured bolts and rivets are placed in these boxes and handled direct to a flat car by a monorail carrier, to be unloaded at the store's platform by means of the truck. This truck is also used to transport car and other brasses from the stores to the rebabbitting plant, a special cage or open platform being substituted for the standard box in this case. While a large number of the boxes are required, they may be made from scrap material at a low cost, and the saving effected in the handling of small material very rapidly offsets the initial expense.

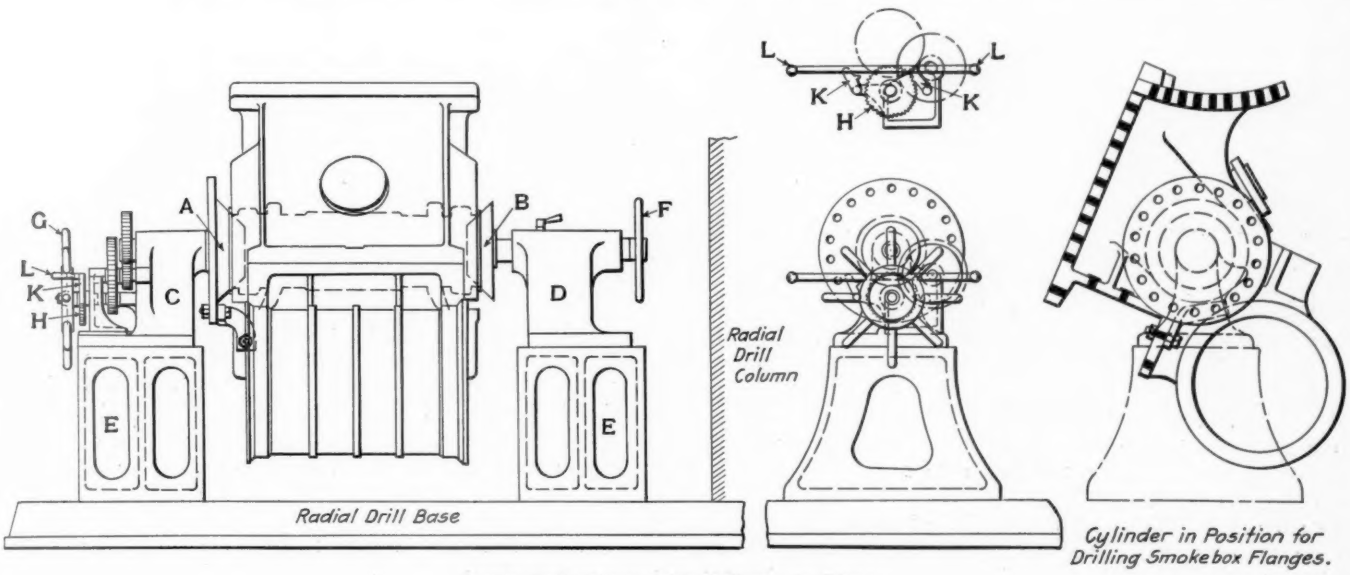
RADIAL DRILL CHUCK FOR LOCOMOTIVE CYLINDERS

BY R. J. HICKMAN

A chuck for use on the base of a radial drill when drilling locomotive cylinder castings, is shown in the drawing. The device is designed for use with piston valve cylinders and the casting is swung about the axis of the valve chamber. By revolving it about this axis, any adjustment of the cylinder may be made to provide for the drilling of all holes at right angles to the axis of the bore.

The cylinder is carried on cone centers shown at *A* and *B* in the drawing, which are mounted on the head stock *C* and the tail stock *D* respectively. The head stock and tail stock are heavy iron castings which are mounted on cast iron bases *E*, the latter serving to raise the centers the required distance above the base of the radial drill. The tail stock is fitted with a lead screw and clamp of the same type used on lathes; the handwheel *F* operates the lead screw and serves as a means of adjusting the distance between the cones when clamping the cylinders in place.

Cone *A* may be revolved about its axis in either direction by means of the handwheel *G* and a gear train. To a flange at the base of the cone is secured a driver plate which is bolted



Radial Drill Chuck with Cylinder in Place

to the cylinder, causing the latter to revolve when the cone is revolved. Thus any portion of the cylinder casting may be brought into position at right angles to the drill spindle, where it is clamped by means of a ratchet and pawl device. The ratchet wheel *H* is rigidly mounted on the shaft of the operating wheel *G*. Two pawls *K*, one mounted on either side of the ratchet wheel, engage the latter and are attached to a handle *L* in such a manner that when one pawl is engaged, the other is simultaneously disengaged from the ratchet wheel. Which of the two pawls is to be used depends upon how the weight of the cylinder balances in any particular position. As the excess weight is shifted from one side of the vertical center line to the other, the position of the pawls must be changed by means of the handle *L*. The reduction gears facilitate the movement of the cylinder by hand.

By carrying the cylinder on the axis of the valve chamber bore, the weight of the casting is very well balanced, and comparatively small cones may be used. It is possible, however, by using large cones, to mount the casting on the axis of the cylinder and this practice is followed when slide valve cylinders are to be drilled. When used in this manner the head and tail stocks are removed from the castings *E* and mounted directly upon the radial drill base, thus keeping the cylinder at about the same height as when swung about the axis of the valve chamber.

GETTING THE MOST OUT OF TOOLS*

BY B. W. BENEDICT
Director Shop Laboratories, University of Illinois

The problem of getting the most out of tools is larger than the selection of the tool itself, as a number of factors enter into it. The function of a tool is to produce work. Obviously a tool has no power within itself to do this—it is not a force but a medium through which a force works upon some object. Consequently the elements of force and material must receive equal consideration with the tool. Production is a three-sided problem of: (a) the worker as the producing unit; (b) the material as the unit worked upon; (c) the equipment as the unit worked with.

Unless these elements have an effective working relationship the final results will not be acceptable even though the various elements possess individual merit. Good tools must go hand in hand with efficient methods.

The essential difference between well organized and unorganized industry is that in the first the management assumes the responsibility of operating the plant and in the second the management throws this burden upon the worker. If a job is assigned to a worker without definite operating instructions, good tools and proper materials, clearly the responsibility for getting out the job is put squarely up to the worker. Under such conditions the worker performs the work in his own way and with such tools as he is able to muster. If on the other hand the management has determined the best methods for performing the work, the worker proceeds along definite and efficient lines which are stamped with official approval. Inefficiencies in the shop, high costs of production, low quality of work done are chargeable to the management and not to the worker. Efficiency has its beginnings in the office—it does not originate in the shop and work backward, to the office. The worker follows the course mapped out for him—if it is efficient he is efficient or out of a job. On the other hand if the central ideal is low and the conceptions narrow the worker will not rise above an inferior performance. Getting the most out of tools is a problem of management.

Of the three elements of industry mentioned previously the

*Abstract of a paper presented at the seventh annual convention of the American Railway Tool Foremen's Association, held in Chicago, July 19 to 21, 1915.

worker undoubtedly is the most important from every standpoint. Tools always will perform the functions required of them by applying the rules that govern their use. But the worker introduces an entirely different series of problems that are not susceptible to the same certain treatment. The human being cannot be standardized like materials or tools nor controlled in the same manner as inanimate things through the medium of concrete laws. But on the other hand working forces respond very readily to control based on an understand-

FORM 134
A 24-2 INSTRUCTION CARD
SHOP LABORATORIES
MACHINE DEPT.

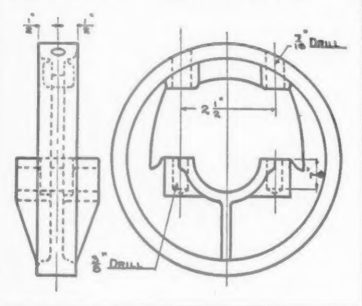
CRANKSHAFT CENTER BEARING SUPPORT
PATT. NO. 1-9
OPERATION NO. 2 — 4 TOTAL OPERATIONS

MACHINE DRILL PRESS
MACHINE NO. 123

TOOLS	
#2 MAGIC CHUCK	CH. 13.1
3/8" DRILL	DR. 20.9
7/16" DRILL	DR. 20.13
"AA" SOCKETS	SO. 3.10

JIGS: DRILL JI. 24.2
FIXTURES:

STOCK NO. A 24 PATTERN NO. 1-9



ITEM	OPERATION ROUTINE	STANDARD TIME
1.	Place Magic chuck in spindle of drill press and insert 7/16" drill. Par. ...	0.01
2.	Adjust speed. Speed No. 1. Par. ...	0.01
3.	Clamp jig to platen of drill press. Par. ...	0.02
4.	Place crankshaft center bearing support in position for drilling. Par. ...	0.01
5.	Drill two 7/16" holes. Par. ...	0.04
6.	Remove 7/16" drill from Magic chuck. Par. ... (Do not stop drill). Place 3/8" drill in chuck. Par. ...	0.01
7.	Drill two 3/8" holes. Par. ...	0.04
8.	Remove part from jig and place in tote box. Par. ...	0.01
9.	Remove Magic chuck and drill from drill spindle. Par. ...	0.02
	Standard time in lots = Total pieces x 0.11 + 0.06	
	TOTAL STANDARD TIME	0.17

Typical Instruction Card

ing of the aims, desire and nature of the human being. There are four factors that bear directly on the efficiency of the worker namely: (a) Selection; (b) Supervision; (c) Instruction; (d) Environment.

Workers have not been selected but hired. As a result a comparatively small proportion of workers are filling positions they are particularly fitted for—the large majority are misplaced and rendering indifferent service through no actual faults of their own. In the same way as science is employed in selecting the right materials it must be called upon to aid in placing each worker where he can do his best work.

Competent leadership is one of the essential factors in efficient operation of the shop that is not given the attention it deserves, although its importance is everywhere recognized. Leadership is not the exercise of driving power but of ability to incite and direct men in conduct and achievement. Every shop foreman thoroughly versed in his work, honest, fair minded, industrious and progressive, will assume natural leadership over his men. The worker will loyally support the foreman who is mentally and morally competent to assume leadership but he refuses that support to an inferior. His judgment furthermore in this matter is unerring—you cannot misead him.

In the absence of definite instructions the worker employs methods that he has previously acquired through training and observation. Whether these methods are good or poor depends upon circumstances which hitherto surrounded the worker. Only a few workmen out of the total are home trained. Most of them come from other localities and other shops where different ideals and methods prevail. The task of the manager is to harmonize the various practices and methods which are thus imparted from many quarters, with the established practices of the shop. This cannot be accomplished without the aid of definite written standards. Verbal instructions and orders are not at all sufficient. Standardized shop practice arranged in the form of instruction cards for the guidance of the worker will insure uniformity and efficiency in the performance of shop operations. A typical instruction card is shown herewith. It is in reality a written order from the foreman explaining how to perform the work. It eliminates the costly efforts of the worker who does not know and increases the efficiency of the more intelligent worker. Accurate and explicit working instructions are essential to efficient shop operation.

The worker is a human machine which does its best work only under conditions favorable to physical, mental and moral well being. Neglect these factors and loss in efficiency is sure to result. Men cannot work efficiently in an environment that lacks the essential elements required by human beings. Poor ventilation causes lassitude from excess of poisonous gases in the air. Excessive heat or cold lowers vitality. Bad water is a very active cause for ill health and disease. Filth, untidiness and accumulated rubbish make slovenly workmen. Gloomy interiors make gloomy workmen. Insufficient natural and artificial light reduce efficiency through eye strain and lack of light to work by. Poor and inadequate toilet and wash-room facilities cause disgust and disloyalty.

Materials are detained certain periods of time at machines while in the processes of production. This detention is unavoidable, but all the time materials are not being worked upon is lost time in so far as output is concerned, as no productive work is done in this interval. Unless some method is employed to direct the course of materials through the proper channels in the shop and without loss of time, production will be curtailed and shortages of finished parts develop during the assemblying process. Materials must be despatched through the shops if such conditions are to be avoided. Despatching is accomplished by establishing manufacturing routes for the various parts and moving these parts on schedule over these routes as successive work operations are completed. The simplest method of despatching is from boards which show graphically the location of each part in the shop. Used in connection with the established production route the movement of parts can be definitely controlled. Maximum production is impossible without systematic despatching.

The third and last important factor in production is the equipment or the medium through which force is employed to change the form of material. Naturally the tool is the last link in the industrial chain as it is only after the worker is available and the character of the materials known that it becomes possible to determine the proper tool to use. The tool problem embodies three elements, namely: (a) selection of the proper tool for the work; (b) maintenance of tool in efficient working condition; (c) manipulation of the tool by efficient methods.

Selection entails a study of the work to be performed on each article or part for the purpose of determining the most effective tools of production. Selection eliminates the poor tool entirely without an expensive and disappointing trial period. A good tool in poor shape will not produce results. Maintenance of tools is a very important item in production. It cannot be neglected without loss in efficiency. The first requirement in an effective maintenance policy is adequate tool and tool storage rooms. In the latter suitable facilities for orderly and convenient storage of tools is of prime importance. The average workman has improper conceptions about methods of grinding and upkeep of tools. More and better work will be secured from tools by having them ground and repaired in the tool room than by the individual workman. Machine grinding is superior to hand grinding. Defective tools should be repaired before returning to storage racks to avoid possibility of re-issue

to shop when in that condition. Standard tool dimensions, cutting angles, hardness, etc., should be established and constantly maintained to secure consistent performance from tools in the shop.

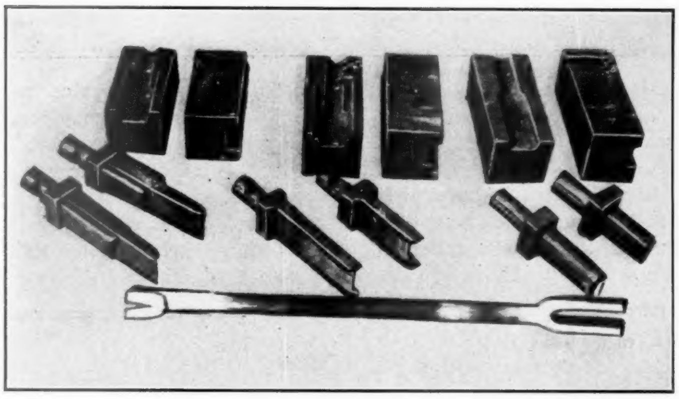
Getting the most out of tools is a complicated but not a mysterious problem. Its details are many but its underlying principles few and clearly defined. The first by their multiplicity obscures the solution but the latter by their simplicity points the way to its successful conclusion.

MAKING BOTTOM BRAKE RODS WITHOUT WELDS

BY WALTER CONSTANCE
Blacksmith Foreman, Reclamation Plant, St. Louis & San Francisco, Springfield, Mo.

At the Springfield, Missouri, reclamation plant of the St. Louis & San Francisco, there is a large accumulation of continuous draft rods 1½ in. in diameter, some of which have been used in making bolts, brake mast steps, etc. In seeking other uses for this material the manufacture of bottom brake rods was considered, and the practice herein described was developed. The entire rod is made from one piece stock, without welds, the jaws being formed on a two-inch Ajax forging machine.

Three sets of dies are used in forming the jaws. Referring to the illustration, the upsetting dies by which the stock for the jaws is gathered, are shown at *A*. In the ends of the plungers used with the upsetting dies are placed inserts of tool steel which



C B A
Dies Used in Forming Brake Rod Jaws from Solid Stock

mark the end of the stock for the splitting operation. One long and one short plunger are provided for single-hole and double-hole jaws respectively. The splitting dies are shown at *B*. It will be seen that they are fitted with grooves at the sides of the opening, in which fit the guides on the plungers. The plungers are thus centered and relieved of any tendency to bend. At *C* are shown the finishing dies in which the jaws are shaped after being split. Two plungers are used, one for the single-hole jaws and the other for the double-hole jaws.

In making these brake rods the stock is first upset and at the same heat is placed in the splitting dies, the jaws being partially split with the short plunger. With the second heat the rod is again put in the splitting dies and the jaws separated to the required depth with the long plunger; the rod is then placed in the finishing dies, the jaws being shaped and the ends finished. Owing to the small size of the machine available for this work, it was found impossible to use the long plunger to start the splitting of the jaws. For this reason a short tool is used to start the split, which is finished with the full length tool. The rod shown in the illustration is finished at one end, while the other shows its appearance after the completion of the first operation.

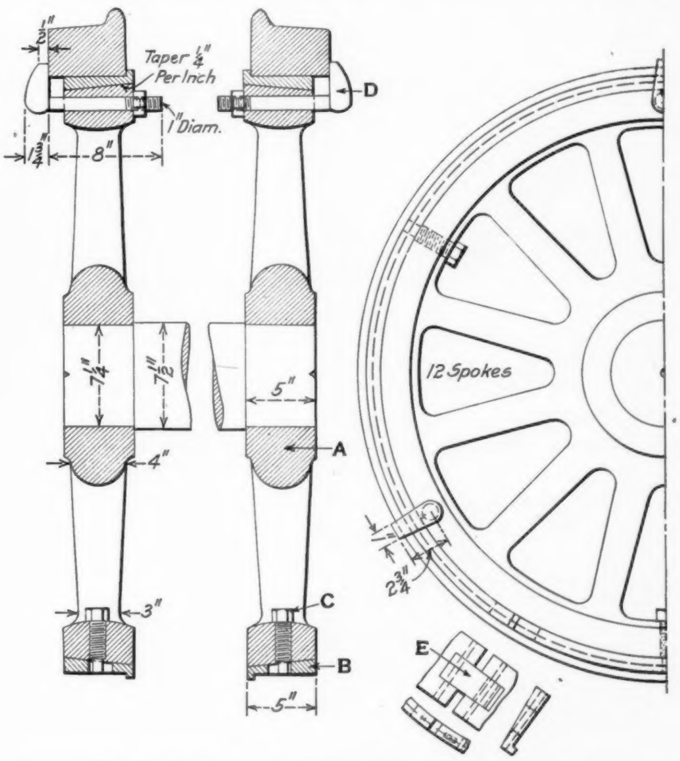
With these tools the scrap iron rods are produced at a cost lower than that for which they can be purchased or made by any other method. Furthermore, the rods are entirely free from welds, either in the jaws or body, a fact of considerable importance from a service standpoint.

EXPANDING MANDREL FOR TURNING LOCOMOTIVE TIRES

BY E. J. BREWSTER
General Foreman, Chicago & North Western, Chicago, Ill.

With the rigidly enforced limits of tread and flange wear now quite generally adopted it is often necessary to turn locomotive driving tires one or more times between shoppings, and the practice of removing the tires without removing the wheels from the engine is followed on many roads. After the tires are removed it is often necessary to shrink them on wheel centers before turning them in a lathe. Several devices have been developed to eliminate the necessity of shrinking on the tires, using set screws or taper keys to hold them in place on the wheel centers. All such devices, however, have a tendency to draw a thin tire out of shape, leaving low spots at points of support after it is turned. With such devices there is also a tendency for the tire to move on the arbor under heavy cuts.

To overcome these difficulties and to facilitate the mounting



Expanding Mandrel for Mounting Tires in a Wheel Lathe

of tires of the same size which may be bored to slightly varying diameters, the expanding arbors shown in the drawing were designed. Two arbor centers *A* which are generally similar to driving wheel centers, but without counterbalances, are mounted on an axle which may be swung between the lathe centers. These arbors are turned tapering on the outside and to them are fitted the split bands *B*, which are provided with shoulders on the inside to line up the tires. These are made in sets of different thicknesses to take different size tires. The screws *C* are threaded through the rim, their outer ends working in slots in the band, and serve to hold the band in place before the tire is mounted. The ends of the band are slotted to receive a block *E*, which is held in place by pins through the ends of the band. The pin hole in one end of the block is slotted, however, to provide for the necessary expansion of the band.

When the tire is in place it is clamped at three points by the

special bolts *D*. These force the tire against the shoulder on the band, which is in turn forced on the taper center, and as it expands it provides a uniform bearing against the tire throughout its circumference. When the tires have been turned they may be very easily removed from the arbors. After the clamp bolts have been loosened all that is necessary is to strike the tires on the inside with a sledge, when they will fall off.

COMPARATIVE LOCOMOTIVE SHOP RATIOS

BY HENRY GARDNER

There are fairly well defined ratios of men and machines to the monthly output of locomotives in railway repair shops. Although the data upon which such ratios are based in any specific case are constantly changing and the ratios only approximately correct, they serve a very useful purpose as a guide when considering important changes in organization and equipment.

In the accompanying tables are presented in detail the ratios for representative locomotive shops located at various points in the East and Middle West. These shops are designated as *A, B, C, D* and *E*. Shop *A* is of the longitudinal type, shops *B, C* and *E* of the transverse type, and shop *D* a roundhouse. Shops *A* and *D* are located on the same road, as are also *B* and *E*. Shops *A, B* and *E* are in the East, while *C* and *D* are in the Middle West.

TABLE I.—COMPARATIVE GENERAL SHOP RATIOS.

Dept.	Total No. of men aver. for one year					Men per working pit					Average No. of Men per loco. out per month‡					Power machines per working pit				Power machines per loco. out per mo.			
	A	B	C	E	D	A	B	C	E	D	A	B	C	E	D	A	B	C	E	A	B	C	E
Erecting	263	288	141	139	99	11.0	7.0	3.0	3.4	6.6	3.6	4.0	2.6	2.0	3.3	.46	.34	.04	.29	.15	.20	.04	.17
Machine*	412	256	252	172	159	17.1	6.2	5.7	4.2	10.6	5.4	3.6	4.7	2.5	5.3	11.4	4.2	2.8	3.3	3.6	2.4	2.5	1.9
Smith	142	74†	138	56†	78	6.0	1.8	2.9	1.4	5.2	1.9	1.1	2.5	.80	2.6	2.3	.66	.73	.51	.72	.38	.65	.30
Boiler	360	252	186	198	87	15.0	6.1	3.9	4.8	5.8	4.7	3.5	3.5	2.8	2.9	1.4	1.1	.73	.85	.43	.64	.65	.50
Tender	88	64	55	40	26	3.7	1.5	1.1	.98	1.7	1.2	.89	1.0	.57	.87	.33	.29	.15	.46	.11	.17	.13	.27
Tin and pipe	114	66	40	29	29	4.7	1.6	.85	.71	1.9	1.5	.92	.74	.42	.97	.13	.07	.02	...	.04	.04	.02	...
Paint	16	27	15	14	6	.67	.66	.31	.34	.40	.21	.24	.28	.20	.20	...	...	...	...	...	...	...	...
Labor gang	45	48	84	26	10	1.9	1.2	1.8	.64	.66	.60	.68	1.6	.37	.34	...	...	...	...	...	...	...	...
Totals	1440	1075	911	674	494	60.2	26.2	19.4	16.5	33.0	19.1	14.9	16.8	9.6	16.5	16.0	6.7	4.5	5.4	5.1	3.8	4.0	3.1

*Includes axle shop, millwright shop and air brake department.
†No power work done in these shops.
‡Average taken for one year period.

Referring to Table I, the number of men per working pit in each department of the shop are shown, as well as the number of men per locomotive repaired per month. The number of working pits and the average number of locomotives turned out each month are as follows:

TABLE II.—COMPARATIVE SPECIAL MACHINE RATIOS.

MACHINE SHOP.

	Lathes				Planers				Drilling Mach's				Shapers			
	A	B	C	E	A	B	C	E	A	B	C	E	A	B	C	E
Machines per working pit	5.4	1.3	.98	1.2	.92	.27	.32	.24	1.7	.49	.47	.32	.58	.22	.15	.19
Machines per loco. out per month	1.7	.66	.85	.67	.29	.14	.28	.14	.53	.25	.41	.15	.18	.11	.13	.09

	Slotters				Bor'g Mills				Milling Mach's			
	A	B	C	E	A	B	C	E	A	B	C	E
Machines per working pit	.33	.12	.08	.13	1.0	.37	.28	.50	.54	.17	.13	.2
Machines per loco. out per month	.11	.06	.07	.05	.32	.19	.24	.20	.17	.09	.11	.10

SMITH SHOP.

	Shears				Punch and Shears				Power Hammers				Forging Machines				Bull Dozers			
	A	B	C	E	A	B	C	E	A	B	C	E	A	B	C	E	A	B	C	E
Machines per working pit	.13	.05	.06	.07	.21	.05	.04	.06	.58	.22	.21	.12	.25	.07	.13	.14	.16	.02	.04	.06
Machines per loco. out per month	.04	.03	.05	.04	.06	.03	.03	.01	.18	.11	.18	.07	.08	.04	.11	.05	.05	.01	.03	.03

BOILER SHOP.

	Shears				Punch and Shears				Punches				Drilling Machines				Bending Rolls			
	A	B	C	E	A	B	C	E	A	B	C	E	A	B	C	E	A	B	C	E
Machines per working pit	.04	.07	.08	.05	.04	.02	.02	.02	.13	.10	.13	.06	.08	.10	.15	.12	.08	.07	.04	.07
Machines per loco. out per month	.01	.04	.07	.03	.01	.01	.02	.01	.04	.05	.11	.03	.02	.05	.13	.07	.02	.04	.03	.04

Note—Machine data for shop D is not available.

Shop.	Number of pits.	Average number of locomotives out per month.
A	24	76
B	41	72
C	47	54
D	15	30
E	41	70

It is, of course, true that the ratios of men and machines to the number of working pits are not of great value for comparative purposes since the divisor may be large or small, depending upon the layout of the shop, without correspondingly effecting the output of the shop. However, it is conceded that the smaller the number of pits in relation to the output, consistent with conservative practice, the more efficient the shop. The grouping of engines on a limited number of pits decreases the working area and centralizes the efforts of the working forces resulting in less waste of time and more effective supervision. The ratio of men to the number of locomotives turned out per month is also open to criticism as a means of direct comparison since some large shops do very little repair work requiring an expenditure of less than $500 per engine, leaving the lighter repairs for the engine houses and division terminal shops. In determining the ratios for the various departments it is also difficult to make proper allowances for differences in organization. For example, in one shop all lagging work is done by the carpenter shop force and in another this work is handled by the tender shop. The data in Table I, however, have been compensated for all such variations in organization and in each case are directly comparable in this regard.

Notwithstanding the many conditions effecting the comparability of the ratios, they may still be of considerable value in a study of shop organization. The following instances may serve to indicate the use to which they may be put. After a careful examination of the plant, the writer was reasonably sure that shop *A* was over-burdened with machines, mostly old-fashioned and obsolete. This opinion is confirmed by reference to the table, where the number of power machines per working pit is shown to be 11.4 for shop *A* as compared with 4.2, the next higher figure given. Also referring to the ratio of machines per locomotive dispatched, it will be seen that the figure for shop *A* is 3.6, which is 4 per cent greater than the next higher ratio. As another instance, the total number of men in the labor gang of shop *C* is given as 84. This seems to be excessive and referring to the ratios it is found to be equivalent to 1.6 laborers for each engine dispatched per month, as compared with the next higher figure of .68 for shop *B*. The machine ratios shown in Table II can only be considered as approximately correct for comparative purposes since one good up-to-date lathe may well be worth two or three lathes of an older and lighter type. What has been said as to the value of the ratios in Table I, however, applies

equally to this table, which may often be found useful as a check on conclusions reached after an examination of any particular shop.

On the whole the figures given in the tables show a considerable variation both in number of men and machines which would indicate that there is room for improvement in some of our railroad shop organizations and equipment. This fact is plainly shown by comparing the total number of men, number of pits and number of locomotives despatched in shops *B* and *E*, these are as follows

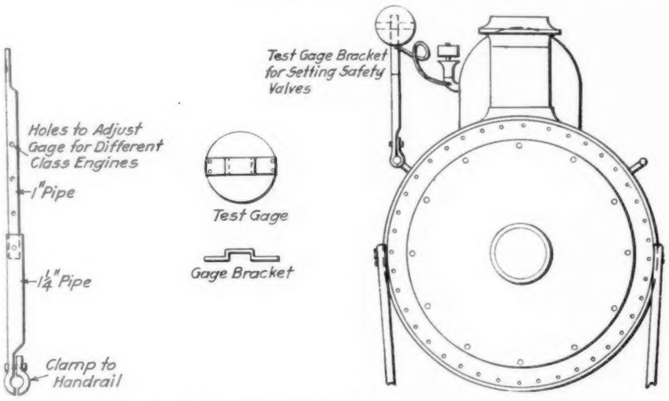
Shop B—1,075 men, 41 pits, 72 engines despatched per month.
Shop E— 674 men, 41 pits, 70 engines despatched per month.

Here we have shop *E* delivering but two less locomotives than shop *B* but with 401 less men. This wide variation may be partly accounted for by a knowledge of the class of work and power handled at these two shops, but it undoubtedly points to a much stronger organization and greater efficiency in the latter shop. It is, of course, understood that the total number of men shown in Table I does not represent all of the men employed, but simply the total number of men in the departments considered.

BRACKET FOR SAFETY VALVE TEST GAGE

BY C. S. TAYLOR
General Foreman, Atlantic Coast Line, Wilmington, N. C.

Rule No. 35 of the Interstate Commerce Commission's rules for the inspection and testing of locomotive boilers, requires the use of two steam gages in setting safety valves. The regular locomotive steam gage answers for one, but it is necessary to have another gage in full view of the operator setting the pops. In many cases this requirement has been met by attaching the second gage to a small wooden bracket placed on top of the cab. On modern locomotives, however, the safety valves are usually located at some distance from the cab, and in



A Convenient Bracket for the Safety Valve Test Gage

roundhouses, where the light is poor, it is difficult for the operator to see a gage so located.

The sketch shows a bracket which may be clamped to the hand rail at any point convenient for the operator, on which the test gage may be placed. It consists of a piece of 1¼-in. pipe within which is telescoped a piece of 1-in. pipe. The lower end of the 1¼-in. pipe is flattened and welded to a simple pipe clamp and upper end of the 1-in. pipe is flattened to fit a socket attached to the back of the gage. Holes drilled through the telescoping portions of the two pipes permit of any desired vertical adjustment of the gage to suit boilers of different sizes. All of our locomotives are provided with an outlet closed with a small globe valve, either in the whistle elbow or in the dome cap, to which the gage syphon pipe is attached when setting the pops.

This stand can be made in any roundhouse, from scrap pipe at a very small cost; it is of light weight and very easily handled. Either copper steam gage pipe or flexible tubing may be used for the steam gage connection.

PISTON VALVE PACKING*

BY F. W. SCHULTZ
District Foreman, Union Pacific, Grand Island, Neb.

My experience with piston valves dates from 1898, at which time they were just coming into use on the western roads. The L-ring was used mostly at first. In about two years the rectangular ring came into use soon to disappear. The T-ring was then tried and its life in my experience was of short duration. In a short while the Z-ring was tried and has been improved until it has finally developed into almost the size and shape of a ractangular ring with the exception of a slight offset, one side being offset a little more than the other. This, from my experience, is the best ring. The L-ring is too light and is used mostly on solid valves. To apply this ring it must be sprung over the end of the valve. This so distorts it that it will not go back to its former shape. The pressure of the steam on the L-ring on the admission side of the valve usually sets the ring too tight to the valve bushing, excessively wearing both the ring and the valve bushing. This soon causes the rings to have an excessive opening which permits the carbon from the oil to be deposited under rings and thus causing a shoulder to be worn in the ring grooves. In the event one or more of these rings get a water jam from the cylinder they stick, usually being closed, which causes a blow and makes an engine lame.

The L-ring on the exhaust side of the valve is likewise too light. Its function is to hold the steam in the cylinder during expansion. The pressure of the steam in the cylinder acting on the outside diameter of this ring will close it and at the same time blow by. This is proven conclusively by the fact that, both rings having equal length of service, the admission rings are worn bright, while the exhaust rings still show tool marks. The moment of exhaust is the only time the exhaust ring will be "set out" against the valve bushing similar to the admission ring. Another objection to the L-ring is that it can not be fitted nor applied to a solid valve as well as the Z-ring can be applied to a built-up valve. The L-ring is practically as expensive to make as the Z-ring and more liable to be broken when applied, especially if there are flaws in the metal, as it is of smaller cross section. This item should not be forgotten when considering the expense of manufacturing the L-ring. The foregoing objections to the L-ring are not true of the Z-ring.

The Z-ring should be used in a built-up valve and properly doweled at the bottom, using as small a dowel as practical. The ring should be carefully faced and fitted in the valve grooves and be made as nearly steam tight as possible. The follower head should clamp the bull ring and not the valve rings. The Z-ring should be from ¾ in. high by ½ in. wide to ⅞ in. high by ¾ in. wide and possibly 1 in. wide, and bored on the inside just large enough so as not to carry the valve but if anything to compel the valve to carry the ring. Some shops have practiced grinding in valve rings. The ring should be given its required snap, then pulled together and clamped in a special chuck and turned to the exact diameter of the valve bushing. By following this practice the ring will have a perfect bearing and also the necessary snap. A heavy ring carried by the valve needs only about 1/16 in. snap, as it will not wear on account of having excessive snap and it cannot be so easily distorted by the pressure of the steam.

The Z-ring should have a proper offset to prevent its getting out of the groove and catching in the steam ports when broken. A Z-ring properly fitted and shouldered has been found broken and still in place with no blow being detected, whereas other types of rings invariably get out of the groove, causing a bad blow and engine failures. A rectangular ring is as good as a Z-ring with one exception, there is no way to secure it to the valve in event of breakage.

Many mechanics and foremen file the rings open, figuring

*Entered in the Piston Valve Packing Ring Competition which closed October 1, 1915.

that the expansion due to the heat of the steam will close them. This is mostly guess work, as I doubt if any have ever found out what expansion takes place. A packing ring of any description filed open is certainly not steam tight. The length of time a new ring would be tight from expansion would be very short as the cylinder walls get hot very quickly. As to the cost of machining, etc., the following are very reasonable figures considering what has to be done. A 15-in. ring of the Z-type can be machined out of ordinary grey iron for 45 cents, labor and material. This depends, of course, upon the facilities, the price of labor and the quality and kind of material used. Some bronze rings of the same type are in use on superheater engines and can be manufactured for $1 each, total cost, including the store expense.

The one important feature of economy is the fuel saving. As above mentioned, an exhaust ring the least bit open is closed by the pressure of the steam, after the steam is in the cylinder, on account of the greatest area being exposed to the steam. The old idea of doweling the rings on the bottom was to prevent blowing, however, the feature of the open exhaust ring closing has been overlooked. Each ring opened 1/8 in. is equal to one ring being open eight times 1/8 in., or one inch, as there are eight rings in two valves. Certainly no one would say a ring open one inch would not blow, especially with 200 lb. of steam. The ring with such a hole in it, possibly blowing continually for six to eight hours, or longer, would eat a big hole in the coal pile.

I have found that 95 per cent of engineers do not favor the wide throttle—Why? They say they lose water; they are correct, but it's the fault of poor packing, or poorly fitted packing. Give an engineer an engine with good, well fitted packing of the Z-type and he will readily see that a wide throttle and a short cut-off does the business. I have found in a great many cases that the cheapness of machining or the total cost of valve rings has been a matter of study and pride instead of the after effects of a cheap job and material on the coal pile. Eight well fitted 15-in. Z-rings applied ready for service would cost $10, including labor and material. When poor rings are used the valves will blow. Any perceptible blow will waste easily a ton of coal on a freight train in 100 miles, which, the coal costing $3 per ton put on an engine, would be a waste of about $90 for fuel alone for one month. Therefore, would it not pay to keep the packing tight?

HELP THE APPRENTICES TO HELP THEMSELVES*

BY MILLARD F. COX
Assistant Superintendent Machinery, Louisville & Nashville, Louisville, Ky.

Men have imitated other men, more or less, in every generation. Boys have done the same thing, and the brightest apprentice soon, almost unconsciously, selects his ideal and proceeds to follow him, or surpass him, according to his ambitions. How necessary is it then to have men in all leading positions whom the boys can look up to and imitate. In my own case, I have in mind one man who could handle a file so skillfully that I found myself practicing at every opportunity to hold my file as he did, and shove it just as expertly. And a certain fellow who could chip faster and smoother than any of the others, I was constantly trying to imitate.

It is important to have attractive courses mapped out, a program of interest to the beginner as well as to the apprentice supervisor. It is also important to select boys who have some real ambition, entirely beyond the sordid desire to reach the journeyman's wage. Few boys realize how little value their services really are to their employers for the first six or eight months. They think more of putting in the time, pay day, and dodging the boss, than of acquiring knowledge. It is an up-hill job to take green boys into a shop and educate them to be useful. The modern method is to have a careful, well trained mechanic to supervise and instruct them, giving his entire personal attention to this branch of the service. To him the boys should have ready access, and he should be competent to answer their inquiries and set them right *on all everyday questions.* If the apprentice supervisor is a mere figurehead the shop will be much better off without him, and you may be sure the boys will soon ignore him.

*Entered in the competition on "How Can I Help the Apprentice?" which closed September 1, 1915.

The well-known modern apprenticeship courses, now so popular in many of our large railroad shops, have done much in the right direction The mechanical journals have also aided in many ways. The heads of our large railroad systems have encouraged the leaders in these movements to some extent. All combined, however, will never do for the boy what he must do for himself, and so I say to the young men of every branch, and in every shop, we are perfectly willing to *help you help yourself,* and it depends on you more than it does on us. Show a willingness by being in your place regularly; don't be too well satisfied with yourself; work from under the task, no matter how arduous it may seem at first, it will come lighter as the chips fly. Give your employer good measure, heaped up and running over of your time; finish the job even if the whistle has blown several minutes ago. What is a few moments compared to the satisfaction of a "Well done, my boy," from your boss? It's worth the price and more. It is the nearest equivalent to a raise of pay.

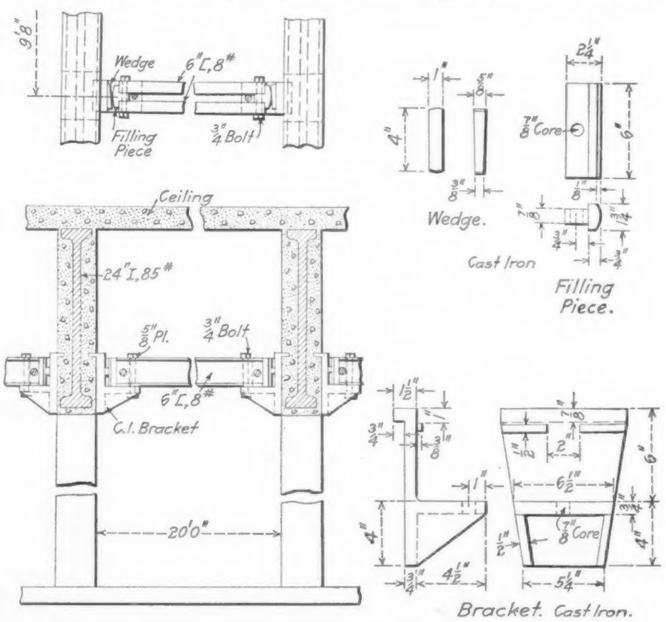
I am willing to help any boy in any way that I can that is willing to help himself some. No others need apply. This has been my attitude towards the apprentice for many years, for whom I have a very friendly feeling.

SUPPORTING SHAFTING IN CONCRETE BUILDINGS

BY C. C. LEECH

The securing of supporting beams for line and counter shafting often presents a serious problem in buildings of concrete construction. Even where it is permissible, the drilling of holes through the concrete and the imbedded steel requires considerable labor and expansion bolts require a very accurate layout.

The writer was called upon to solve a problem of this char-



Details of Shaft Supporting Beams for a Concrete Building

acter where some thirty machines were to be installed, none of them motor-driven and all requiring the usual overhead countershafts. In the illustration is a sectional elevation of the building showing a portion of ceiling and floor and the imbedded

I-beam construction of the frame. The distance from pillar to pillar across each bay is 20 ft., and to span this space 6-in. 8-lb. steel channels were used, bolted together in pairs.

The details of the arrangement finally adopted, by which the channels were attached to the concrete, are clearly shown. Recesses were cut in the concrete at the proper height to receive the 1-in. by ¾-in. flanges on the top of the cast iron brackets. The channels, assembled with special cast iron filling pieces, or shoes, between the ends were then placed on the brackets and secured by ¾-in.bolts passing through a short ⅝-in. plate and between the channels. The entire assembly was then securely locked in position by driving wedges between the backs of the brackets and the channel shoes.

After the installation had been completed and the line shafting tested a variation of but ⅛ in. was detected in a length of 125 ft.

REPORT OF THE CHIEF INSPECTOR OF LOCOMOTIVE BOILERS

The following is taken from the fourth annual report of Chief Inspector of Locomotive Boilers McManamy to the Interstate Commerce Commission:

The work of the division of locomotive boiler inspection during the year has been substantially the same in character as the work of that division in previous years. The tables show in concrete form the number of locomotives inspected, the number and percentage found defective and the number ordered

	1915	1914	1913	1912
Number of locomotives inspected	73,443	92,716	90,346	74,234
Number found defective	32,666	49,137	54,522	48,768
Percentage found defective	44.4	52.9	60.3	65.7
Number ordered out of service	2,027	3,365	4,676	3,377

Locomotives Inspected, Number Found Defective and Number Ordered Out of Service

out of service on account of not meeting the requirements of the law during each of the four years the law has been in force. They also show the total number of accidents due to failure from any cause of locomotive boilers or their appurtenances and the number of persons killed or injured thereby,

	1915	1914	1913	1912
Number of accidents	424	555	820	856
Decrease from previous year . . . per cent	23.6	32.3	4.2	....
Decrease from 1912 . . . do	50.5	....	....	....
Number killed	13	23	36	91
Decrease from previous year . . . per cent	43.5	36.1	60.4	....
Decrease from 1912 . . . do	85.7	....	....	....
Number injured	467	614	911	1,005
Decrease from previous year . . . per cent	24	32.6	9.3	....
Decrease from 1912 . . . do	53.5	....	....	....

Number of Accidents and Number Killed or Injured

with the percentage of decrease each year since the law became effective; also the total decrease during that period. The data contained therein reflect the work performed and the results accomplished and further explanation or comment need not be made.

One of the tables shows the total number of persons killed and injured by failure of locomotive boilers or their appurtenances during the past four years, classified in accordance with their occupations.

All accidents reported have been carefully investigated, the cause determined, when possible, and the information thus obtained given to the carriers; and this has been an important factor in reducing the number of accidents.

Prompt reports of accidents materially assist in the work of investigation and reduce the delay to equipment, and as carriers now fully understand the requirements in this respect such reports, with rare exceptions, are properly made.

While the total number of accidents has greatly decreased, two particular types show an increase over the previous year. These are accidents due to defective blowoff cocks and to injector steam pipe failures.

During the year there were 20 accidents due to defective condition of blowoff cocks or their operating mechanism, resulting in 1 killed and 19 injured. The fact that every one of these accidents was due to defects in the blowoff cock, or in

	Year ended June 30—							
	1915		1914		1913		1912	
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
Members of train crews:								
Engineers	5	150	8	187	12	268	22	310
Firemen	7	207	8	290	12	478	19	491
Brakemen	....	40	....	46	6	79	8	79
Conductors	1	4	1	6	2	7	4	16
Switchmen	....	4	....	1	....	2	....	7
Roundhouse and shop employees:								
Boiler makers	....	5	1	18	....	10	2	3
Machinists	....	10	2	5	....	11	7	11
Foremen	....	2	1	6	....	4	1	4
Inspectors	....	3	....	3	....	3	1	2
Watchmen	....	1	1	7	....	8	3	6
Boiler washers	....	9	....	8	....	4	1	4
Hostlers	....	6	....	9	1	6	....	5
Other roundhouse and shop employees	....	2	1	17	1	24	14	62
Other employees	....	2	....	10	....	4	3	3
Nonemployees	....	1	....	1	2	3	6	2
Total	13	467	23	614	36	911	91	1,005

Total Number of Persons Killed and Injured, Classified by Occupations

the piping or operating mechanism, which could have been discovered by reasonable inspection, clearly indicates that these appurtenances are not receiving the same careful inspection and attention that other appurtenances are; therefore, the remedy is obvious.

Twenty-eight accidents due to failure of injector steam pipes, resulting in one killed and 30 injured, occurred during the year. These failures can be divided into two general classes, viz., failure of union nut and failure of brazing sleeve or collar, both of which are in many instances contributed to by failure to properly brace the injector.

Failure of union nut is usually due to thread stripping, nut too large, or nut broken, which in practically every instance was caused by the use of improper tools, such as hammer and chisel, or set, in tightening the nut; and our investigations have shown that the use of such tools is not confined to the enginemen on the road where proper tools are not available, but can be said to be almost a general practice of repairmen at terminals. While the failure does not always occur at the time the improper tools are used, it results in stretching or otherwise damaging the nut, ultimately resulting in failure which frequently causes injury.

Failure at brazing sleeve or collar is usually due to poor brazing, allowing the pipe to pull out of the sleeve, or failure of sleeve due to the fact that the spelter did not flow between the sleeve and pipe, resulting in the sleeve being brazed to the pipe only at its extreme end; therefore, the strain of the load and vibration, which should have been borne by the copper pipe, is thrown on the brass sleeve, which is not designed nor intended to carry it.

Investigation of all such accidents which have occurred during a period of more than four years has convinced us that failure of brazing or brazing sleeves can be practically eliminated by the adoption of what has been termed a "mechanical joint," which is made by extending the copper pipe through the sleeve, expanding it, and beading or flanging it over so that it will be firmly held in the union. This not only throws the load on the pipe, which is designed to carry it, but also makes it possible to determine by inspection before the pipes are applied whether or not the work has been properly done, which is not possible with the brazed joint.

We have been persistently recommending this form of joint, and as it is being adopted by many carriers and manufacturers as standard, we have refrained from recommending a rule requiring its use; but unless a reduction in accidents from failure of the steam pipes at the brazing sleeve can otherwise be brought

about, some action in this direction will become necessary.

The number of applications for an extension of time for removal of flues, as provided in rule 10, has increased over the previous year, and this has materially added to the work of this division, as such extensions are granted only after a special inspection of the locomotive has been made. During the year 1,099 applications for extension of time for removal of flues were filed by 284 carriers; of this number 638, or 58 per cent, were granted; 461, or 42 per cent, were refused or granted only after defects disclosed by our inspection had been properly repaired.

The rule referred to requires all flues to be removed at least once every three years and a thorough examination made of the entire interior of the boiler; that after flues are taken out the inside of the boiler must have the scale removed and be thoroughly cleaned. The rule also provides that this period

Nature of failure or defect.	Year ended June 30—											
	1915			1914			1913			1912		
	Accidents.	Killed.	Injured.	Accidents.	Killed.	Injured.	Accidents.	Killed.	Injured.	Accidents.	Killed.	Injured.
Arch-tube failures	7	....	9	12	....	19	20	3	27	18	....	23
Ash-pan blowers defective	11	....	11	5	....	5	14	1	14	3	....	3
Blowers defective	5	....	5	11	....	11	13	....	13	11	....	12
Blow-off cocks defective	20	1	19	15	1	15	16	....	18	23	2	22
Boiler checks defective	9	....	10	14	....	14	11	....	12	11	1	11
Boiler explosions:												
A. Shell explosions	......	....	......	1	....	1	......	....	......	3	27	41
B. Crown-sheet failures due to low water where no contributory causes were found	14	7	20	36	13	59	44	23	67	69	35	129
C. Crown-sheet failures due to low water where contributory causes or defects were found	9	1	14	12	3	18	28	6	50	23	15	38
D. Fire-box failures due to defective staybolts, crown stays, or sheets	1	2	......	4	1	7	5	....	8	1	1	1
E. Fire-box failures due to water forming	1	....	1	1	....	2	1	2	......	1	3	......
Cross stays defective	......	....	......	......	....	......	1	....	3	......	....	......
Crown stays defective	......	....	......	......	....	......	1	....	1	......	....	......
Dome caps defective	3	....	3	......	....	......	2	....	2	2	....	2
Draft appliances defective	2	....	2	1	....	1	4	....	4	3	....	4
Exhaust nozzle breaking	......	....	......	......	....	......	1	....	1	......	....	......
Fire doors defective	......	....	......	......	....	......	2	....	2	......	....	......
Fire-hose failures	5	....	6	3	....	3	......	....	......	......	....	......
Flue failures	41	....	52	51	....	56	54	1	63	56	1	62
Flue-plug failures	2	....	2	......	....	......	......	....	......	7	....	8
Flue pockets defective	......	....	......	3	....	4	2	....	2	3	....	4
Flue sheets defective	......	....	......	......	....	......	1	....	1	2	....	2
Gauge cocks defective	3	....	3	3	....	3	2	....	2	4	....	4
Grates defective	......	....	......	......	....	......	1	....	1	......	....	......
Handhole plates defective	......	....	......	1	....	1	......	....	......	1	....	1
Injectors and connections defective (not including injector steam pipes)	29	....	31	33	....	33	28	....	28	47	....	48
Injector steam-pipe failures	28	1	30	15	....	18	36	....	47	31	....	38
Lubricators defective	8	....	8	14	....	14	11	....	12	11	....	12
Lubricator glasses bursting	13	....	14	20	....	20	45	....	45	49	....	49
Lubricator piping defective	2	....	2	8	....	9	4	....	5	......	....	......
Mud-drum failures	1	....	4	1	2	2	......	....	......	......	....	......
Mud ring defective	......	....	......	......	....	......	......	....	......	1	....	1
Patch bolts defective	1	....	1	......	....	......	......	....	......	1	....	1
Plugs (arch-tube) defective	1	....	2	4	1	5	......	....	......	2	....	4
Plugs in fire-box sheets defective	1	....	1	6	....	7	5	....	6	1	....	1
Plugs (fusible) defective	......	....	......	2	....	2	1	....	1	1	....	1
Plugs in steam chest defective	......	....	......	......	....	......	1	....	1	......	....	......
Plugs (washout) defective	15	....	18	17	1	17	20	....	23	11	2	14
Rivets defective	1	....	1	4	....	5	2	....	2	......	....	......
Safety valves defective	2	....	2	1	....	1	1	....	1	......	....	......
Squirt-hose failures	99	....	100	139	....	140	266	....	267	243	....	245
Stay bolts defective	3	....	5	5	....	5	2	....	3	9	....	11
Steam-heat hose defective	1	....	1	......	....	......	1	....	1	......	....	......
Steam piping defective	4	....	4	14	....	16	5	....	6	11	2	11
Studs defective	16	1	17	18	....	21	20	....	21	14	....	16
Superheater-tube failures	1	....	3	......	....	......	1	....	2	1	....	1
Tank hose defective	......	....	......	2	....	2	3	....	3	......	....	......
Throttle glands defective	1	....	2	3	....	3	3	....	4	......	....	......
Throttle leaking	1	....	1	1	1	......	......	....	......	......	....	......
Valves defective (not including safety valves)	8	....	8	3	....	3	6	....	6	5	....	5
Water-bar failures	1	....	1	2	....	2	1	....	1	3	....	4
Water glass bursting	48	....	48	60	....	60	128	....	128	165	1	168
Water-glass fittings defective	3	....	3	10	....	10	7	....	7	8	....	8
Miscellaneous	3	....	3	......	....	......	......	....	......	1	1	......
Total	424	13	467	555	23	614	820	36	911	856	91	1,005

Accidents and Casualties from Failures of Locomotive Boilers and Their Appurtenances.

may be extended upon application if an investigation shows conditions to warrant it. Removal of flues once in three years is required primarily to allow a complete interior inspection, as provided by Rule 11, and the making of necessary repairs, and not, as some evidently believe, on account of the condition of the flues.

To properly handle this work, carriers have been asked, when an extension is desired which their inspection indicates conditions warrant, to file applications with the chief inspector approximately 60 days before flues become due for removal, and in each case show:

1. Number of each locomotive for which the extension is desired.
2. Class of service in which the locomotive is engaged.
3. Date of previous removal of flues.
4. Mileage made since flues were removed and interior of boiler cleaned and inspected.
5. Period of time for which the extension is desired.
6. Approximate date when it will be convenient to have the locomotive held and dome cap and throttle standpipe removed to permit an interior inspection by a government inspector; also at what point locomotive will be held for this inspection.

It is to be presumed that carriers desire to properly maintain their locomotives; therefore, an application for an extension of time for removal of flues from a locomotive, which we find on examination to be defective, indicates that the railroad company's inspectors have not discovered the defective conditions.

In some instances it is evident that the application for extension of time has been filed without a proper attempt on the part of the carrier to determine whether the condition of the boiler would justify the application, as Federal inspectors find defects that could scarcely be overlooked if a reasonable inspection were made prior to filing the application, thus making it apparent that they are depending on us to do this work for them. When the conditions found indicate this practice exists, and that careful inspection is not being made by the carriers prior to filing application for extension of time, so they may know their request is a proper one, it becomes necessary for our inspectors to exercise extreme care in making their investigation, and to require the removal of all parts necessary to assure themselves whether or not the request for extension of time may properly be granted.

Alteration reports which are being filed, showing reinforcement of boilers which have a factor of safety below the standard fixed by the order of the Commission, dated June 9, 1914, indicate that diligent efforts are being made by the carriers to meet the requirements of that order, and with a few exceptions very satisfactory progress is being made. A standard alteration report, Form 19, containing carefully prepared instructions for filing such reports in accordance with rule 54, was issued on March 29, 1915. The use of this form in accordance with the instructions will simplify the reporting of alterations to boilers and enable the carriers to avoid considerable unnecessary work which some of them have been doing.

The act of March 4, 1915, amending the locomotive boiler inspection law by extending its provisions to include the entire locomotive and tender and all their parts has presented additional and important problems and will materially increase the work of this division. The preparation of rules fixing minimum limits for all parts of locomotives and tenders, so that the requirements might be definite, has been diligently pursued and is progressing as rapidly as accuracy will permit.

Very satisfactory progress is being made in arranging the work of the division so that the additional duties imposed by the law may be properly performed. This will probably make it necessary for our inspectors to follow more closely the requirements of Section 6 of the law, which provides that their "first duty shall be to see that the carriers make inspections in accordance with the rules and regulations established or approved by the Interstate Commerce Commission, and that carriers repair the defects which such inspections disclose," before the locomotives are again put in service, and may result in eliminating reports to railroad officials of minor defects discovered by federal inspectors, which, for the benefit of the carriers, have been directed to their attention; therefore, it will be necessary for each railroad company's inspectors to give more careful attention to such matters, as no change will be made in the method of handling violations of the law or the rules.

No formal appeal from the decision of inspectors, as provided in Section 6 of the law, has been filed during the year. In one instance, an appeal was filed from the findings of inspectors in an accident investigation. Reinvestigation by an assistant chief inspector, assisted by inspectors from other districts, not only sustained the original report but disclosed additional evidence in support thereof.

During the year 2,130 defective parts of locomotives not covered by the boiler inspection law, almost all of which were defective wheels, were reported to this division by inspectors and directed to the attention of the railroad officials with request that proper repairs be made before the locomotives were put in service. Such matters are now covered by the amended law, and will be handled in accordance therewith.

HOW CAN I HELP THE APPRENTICE?*

BY WALKER V. HINEMAN
Roundhouse Foreman, Chesapeake & Ohio, Russell, Ky.

The first and most important step in helping the apprentice is in proper selection. The old rule of boys placing their applications on file and receiving positions when their turn comes, or worse yet, the order of giving the old employees' sons the preference, should be suspended at once. Many a boy has undertaken to learn the machinist trade because his father was a machinist and at the time of entering his apprenticeship did not have the slightest idea of the seriousness of the undertaking. If asked what a machinist was he would say, "one who runs a machine."

The candidate should have a good common school education—the best a boy of sixteen can possibly obtain to-day. He cannot have too much. Better yet, the minimum age should be eighteen and the qualifications should be a diploma from a good high school. I do not think this asking too much, for it would certainly be a great help to the boy. He could not enter a technical school without these qualifications, so why not raise the standard for the apprenticeship applicant? It would make a great many more young mechanics eligible for positions as foremen.

Apprentices should be taken into the service on trial and this rule should be strictly adhered to. It is not fair to the boy to be allowed to spend four years of his life at a trade for which he is in no way fit, and at which he cannot perfect himself. And it is certainly an injustice to the company to allow him to complete his apprenticeship, call himself a journeyman, receive a union card and demand the scale of wages paid in his locality, when he should be "filing back ends" in a dentist's office, or making pills in an apothecary's shop.

Much has been said concerning modern apprenticeship, or the instruction of apprentices in trade schools by railroads. Our railway is one of the leaders in this work, but at the small points and roundhouses these advantages cannot be had. In such cases it is up to the foreman in charge to help the apprentice. This can best be done by taking the apprentice when he first enters the service. Get acquainted with him, instruct him as to his duties and the obligations he is under to the company by binding himself for a four-year apprenticeship, and the obligations he is under to himself to make the best he can of himself while he is serving his apprenticeship. Impress upon his mind the opportunities open to good mechanics and the opportunities open to good apprentices that will try for them. Win his confidence.

Don't try to make him afraid of you and have him calling you the "old man," or some other disrespectful epithet when your back is turned. Give him the best possible chance to master the trade your shop affords. Have confidence in the apprentices and encourage them in their undertakings so they will exert their best efforts. Study their characters and dispositions and handle them accordingly. Spur them on. Put them up against emergencies to give them confidence in themselves.

OIL FOR COMPRESSOR CYLINDERS.—Oil for air-compressor cylinders should have a flashpoint of 550 to 600 deg. F., according to the air pressure and rapidity of compression; for steam cylinders operated with superheated steam upward of 600 deg., according to the amount of the superheat. Saturated steam will not disintegrate oil of 550-deg. flashpoint. For internal-combustion engine cylinders oil of as low flashpoint as will do the work should be used (about 450 deg.).—*Power.*

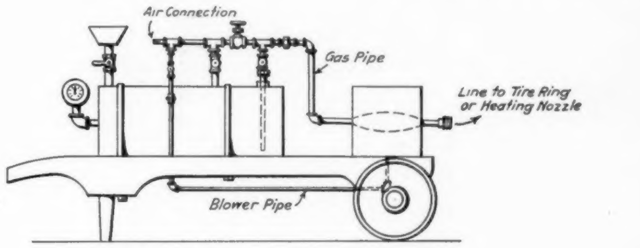
* Entered in the competition on "How Can I Help the Apprentice?" which closed September 1, 1915.

PORTABLE KEROSENE VAPORIZER

BY H. E. OPLINGER
General Foreman, Atlantic Coast Line, Brunswick, Ga.

By means of the device shown in the drawing kerosene has been very successfully used in heating tires and for other heating operations in the shop requiring a portable burner. The equipment is mounted on an old shop truck of the usual type, and consists of an old auxiliary air drum and a coke furnace for vaporizing the oil, both of which are securely attached to the truck frame.

The furnace is a box 12 in. by 12 in. by 12 in., made of 1/4-in. boiler plate, the bottom being perforated with 3/8-in. holes. A lift door is placed on one side, through which the fire may be removed when not in use. Within the furnace is a cast-iron



Vaporizer for Burning Kerosene

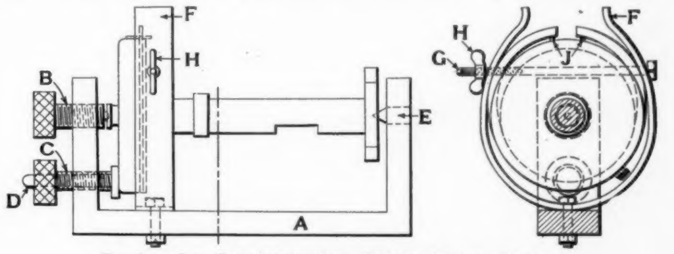
gas generator 12 in. long and 2 1/2 in. in diameter at either end, expanding in section toward the center of the furnace at which point it has a diameter of 4 in. Into the ends are tapped 1/2-in. pipes, one of which is connected to the oil tank and the other to the pipe line leading to the tire heating ring, or other type of burner, as the case may be. A 3/8-in. blower pipe leads from the air line to the bottom of the furnace.

When the device is to be placed in operation a coke fire is built in the furnace, and is kept burning throughout the period of operation. This raises the gas generator to a red heat, and keeps it in that condition, the kerosene thus being completely vaporized before passing to the burner; the result is a steady, blue flame. The device may be operated by any handy man with perfect safety, and the cost of operation is very low.

STRAIGHTENING TRIPLE VALVE PISTONS

BY J. A. JESSON

It is the general practice to straighten in a lathe the stems of triple valve pistons which have been bent, a practice so expensive as to often be prohibitive. The drawing shows a device



Device for Straightening Triple Valve Pistons

which has proven very successful in reducing the cost of this work, the operation of which is very simple.

The body of the device *A* is made from bar iron 1 1/4 in. square, the end being forged at right angles to the yoke and fitted with the centers *B* and *E*. The piston to be straightened is placed between the centers and secured by the adjustable center *B*. At *C* is shown a hollow screw threaded through the end of the body. Working freely in this screw is a brass pin *D* with a flat head on the inner end. When the piston is in place it is revolved and the screw *C* is adjusted until the end of the

pin D is brought in contact with the nearest point on the face of the piston. The straightening is effected by lightly striking the outer end of the pin, continuing to turn the piston and operate the screw C until the head of the pin touches the surface of the piston all around.

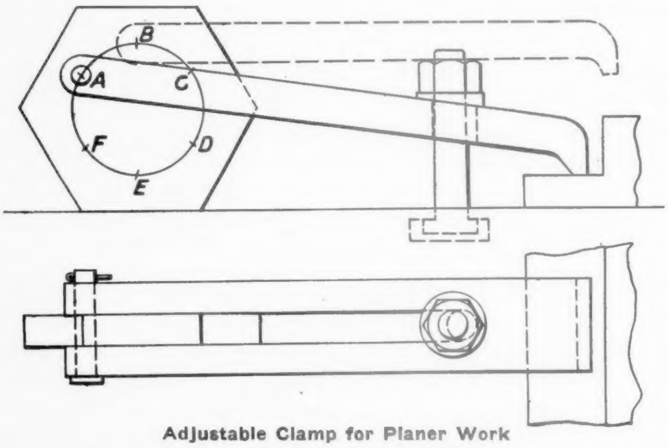
This device also serves to hold the piston while filing down the ends of the rings in fitting them to the cylinder. The piston is clamped tightly between the centers and the ends of the ring blocked up out of the groove by means of the wires J. After placing a file between the ends of the ring, the latter is closed by pressure from the spring clamp F, which is tightened by means of the bolt G and thumb nut H, thus pressing the ends against the file.

QUICK ADJUSTMENT PLANER CLAMPS

BY ROBERT W. ROGERS

The type of clamp usually provided for holding down work on the planer table requires the use of blocking to adjust for the varying height of the work. This is unnecessary with the clamp which is shown in the drawing, as it is adjustable in itself.

The device consists of a hexagonal block to which is pinned



Adjustable Clamp for Planer Work

one end of the forked clamping arm. The point of attachment, shown at A in the illustration, is eccentric with the axis of the hexagon and by turning the latter this point may be brought into any of the other positions indicated. Any one of four different heights thus may quickly be obtained.

The principle may be extended, as for instance, by using an octagon block instead of the hexagon, which will increase the number of steps in the range of the adjustment. This clamp is a European device, which has proved of considerable value in planer work.

SUGGESTIONS ON APPRENTICESHIP*

BY AN OLD APPRENTICE

In the average railroad shop which has not progressed to the point of having an apprentice instructor the apprentice is such in name only He is a wandering waif without a friend; there is no kind hand to guide him. If he amounts to anything it will be in spite of his environment, not because of it.

One apprentice course I have in mind looked fine on paper. After reading it over you would have rubbed your hands together with satisfaction and said, "surely here they are turning out good mechanics." What was really happening? One bright ambitious boy was kept for over two months cutting off flue thimbles, a job about which you could learn everything in one day.

Now the thing which was lacking in that shop was someone to take an interest, some one to see that when the course called for three months lathe work the time was not all spent in cutting off flue thimbles, a job for some old man about ready to be retired. When this boy finally got desperate and raised an objection he was branded by the foreman as "impatient and a kicker."

In another shop the work was changed often enough, but when the man in charge made the prescribed changes he considered his duty ended. There was no one who took the time or trouble to suggest to or instruct the beginner. What happens we know only too well—Munsterberg has put it very aptly as follows: "The apprentice approaches the instruction in any chance way, and the beginner usually learns even the first steps with an attitude which is left to accident. An immense waste of energy and a quite anti-economic training in unfit movements is the necessary result."

In every shop there should be some one big hearted and wise enough to take up the cause of the apprentice. Make the matter personal. Why not *you*. Certainly it will do you no harm, and while it may take up a little of your time, you will have the feeling of having done something worth while.

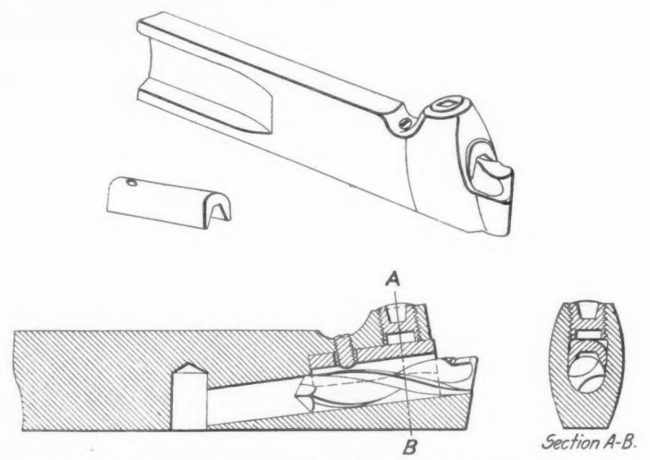
Are you, Mr. Foreman, or Mr. Master Mechanic, deeply interested in the careers of the young "mechanics-to-be" for whom you are responsible? Are you interested to the point that you know them by name, have their confidence, and have at the end of their course a well defined idea of what class of work each one is best fitted? If you do not measure up to this standard your whole organization will ultimately suffer, and you are missing an opportunity to broaden your view point and sympathies, which is distinctly your own personal loss as well as the loss of the apprentices.

* Entered in the competition on "How Can I Help the Apprentice?" which closed September 1, 1915.

SPECIAL TOOL HOLDER FOR BROKEN DRILLS

BY W. C. STEPHENSON
Assistant Machine Foreman, Atlantic Coast Line, Rocky Mont, N. C.

A special tool holder is in use at this point by means of which drills broken two or three inches from the cutting end, and all types of broken drill shanks may be used as cutting tools for turning, facing, threading or finishing operations. The essential features of the device are clearly shown in the drawing. The body of the holder is drilled as clearly shown in the longitudinal section, the opening at the end of the tool being



Holder Using Broken Drills for Cutting Tools

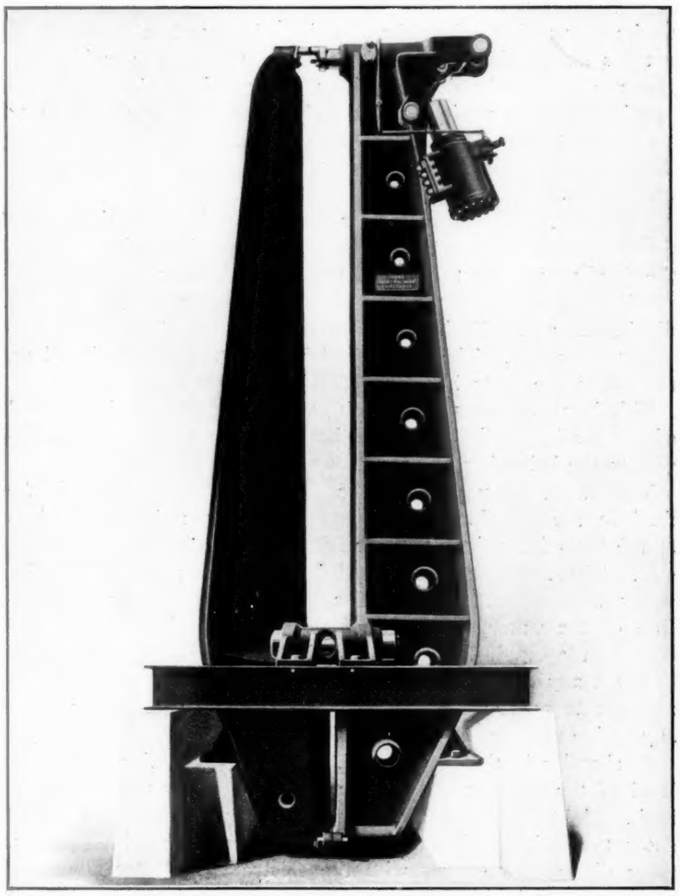
enlarged to receive an adjustable clamp block. The clamp has two divergent gripping surfaces, the angles of which cause the clamp to securely wedge the tool into position laterally, the clamp being tightened by means of the socket set-screw. The clamp block is retained in the holder by a small screw extending into a hole near its inner end. This screw is threaded in the holder but not in the block.

NEW DEVICES

LARGE PNEUMATIC RIVETER

Two riveters, which are believed to be the largest pneumatic riveters ever constructed, have recently been built by the Hanna Engineering Works, Chicago. The machines have a reach of 21 ft. and are capable of exerting a pressure of 100 tons on the rivet dies at 100 lb. air pressure. The machines weigh 40 tons each, and an idea of the size and type of construction may be obtained from the accompanying photograph.

Until the development of the Hanna combined toggle and lever system for transmitting the pressure from the air cylinders



High Capacity Pneumatic Riveter

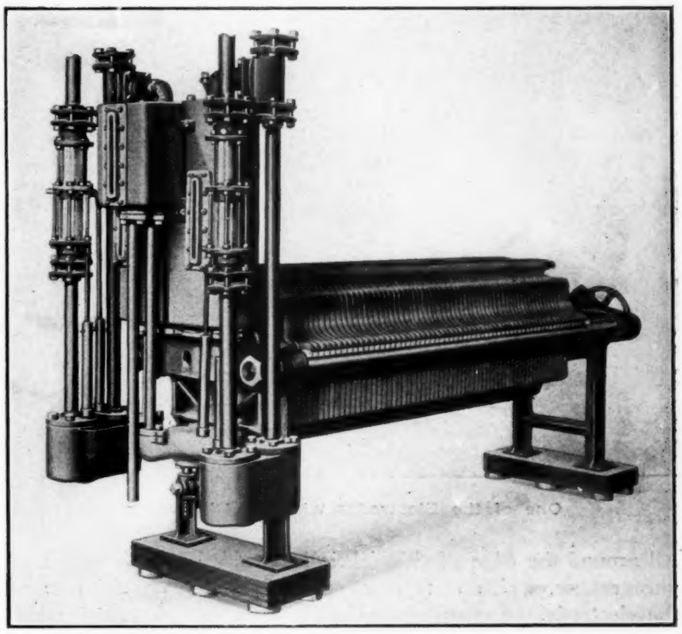
to the rivet dies, steam tight riveting for high pressure requirements was done almost wholly by hydro-pneumatic or hydraulic machines. The hydro-pneumatic principle has had a comparatively limited use on account of the difficulty in maintenance, due to the excessive pressure set up in the intensifying chamber. The straight hydraulic riveters have, therefore, received the widest application. The Hanna type pneumatic riveter is fitted with a toggle system designed to give a large opening of the dies, the pressure gradually increasing as the toggle movement closes until the desired maximum is reached. A simple lever movement then operates through the remainder of the stroke under approximately uniform maximum pressure, the movement of the die during this part of the stroke being great enough to remove all uncertainty as to the pressure applied to the rivet. When the machine is once adjusted for a certain length of rivet and thickness of plate, this movement is of sufficient extent so that no further adjustment for ordinary variations in length of rivets, size of holes or thickness of plates need be made.

The riveter shown in the illustration is provided with a cylinder having a piston stroke of 22 in., with a die travel of 5¾ in. As in the smaller machines, the toggle action operates during the first half of the piston stroke with an approximate die travel of 4¾ in. At this point the maximum pressure is reached and the mechanism automatically changes to a simple lever action without a critical point in the pressure curve. The remaining 11 in. of piston travel effects the last one inch of die travel at uniform maximum pressure. By the use of a simple pressure regulating valve in the air supply line, the cylinder air pressure may be quickly changed to produce any desired pressure on the rivet dies within the rated tonnage of the machine.

BIPOLAR OXYGEN AND HYDROGEN GENERATOR

An apparatus for the manufacture of oxygen and hydrogen by the electrolytic process has recently been brought out by the International Oxygen Company, New York. This is a bipolar device and is entirely different in construction and operation from the unit type generator built by the same company.

The bipolar generator consists of a series of metallic plates clamped together in a heavy frame, electrically insulated from



Bipolar Continuous Oxygen and Hydrogen Generator

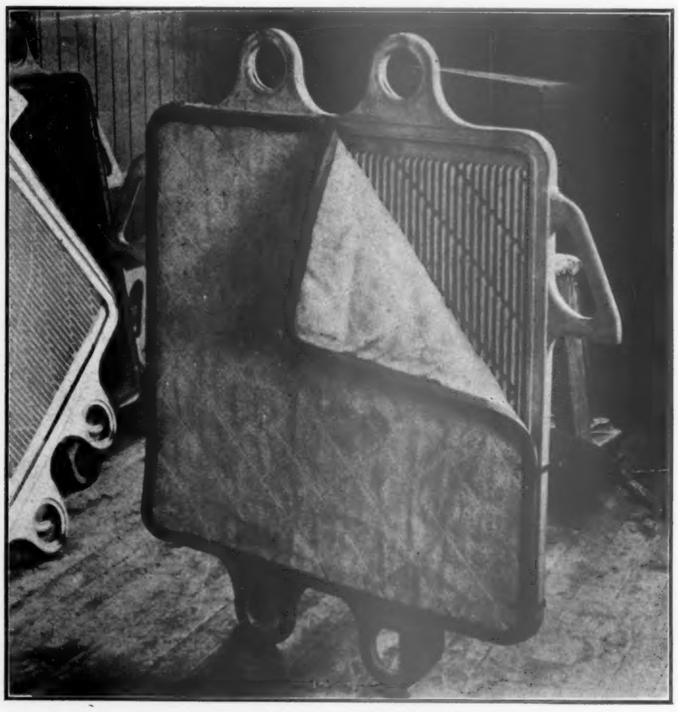
one another, and separated by diaphragms of porous fabric. Each pair of these plates forms a closed cell, divided by the diaphragm. These cells are filled with the electrolyte—caustic potash or soda—which acts as a conductor, the plates acting as the electrodes. An electric current admitted at one end plate passes through the plates and the solution to the other end plate. In its passage it decomposes the water in the solution into the two gases, oxygen and hydrogen, which are released on opposite sides of each plate and emerge upward into the gas offtakes. The mingling of the oxygen and hydrogen in each cell or compartment is prevented by the diaphragm which, while

permitting the passage of the fluid, resists the passage of the gases. As the gases are released and withdrawn, the solution is automatically replenished from a supply tank. The operation is continuous so long as current and electrolyte are supplied.

In the smaller machines the electrodes are carried on two steel rods supported on two heavy end-pieces or pedestals of cast iron. In the larger generator the side rods are replaced by steel bars. The construction is one of extreme rigidity, absolutely proof against any distortion and consequent disarrangement of electrodes, with resultant leakage. Only the two end supports are necessary, no middle support being used.

The electrodes are of a special patented design, the anode side being heavily nickeled, while the cathode side is of commercially pure iron. The surfaces of the electrodes are corrugated, and the corrugations are broken by a large number of depressions, to facilitate the flow of electrolyte into the cell and the release of the gases from it. At top and bottom of each electrode are two circular openings communicating by cored channels with opposite sides of the plate. Those at the bottom are for the water intake, and those at the top are for the gas offtake. It will be seen that each half of each cell has its own independent water intake and gas outlet, so that there can be no possibility of the two gases mingling through these channels.

The diaphragms are of especially prepared asbestos fabric of a thickness and texture carefuly worked out by long experiment.



One of the Electrodes with Its Diaphragm

All around the edge of this fabric is moulded a packing rim of pure rubber, which rests in a recessed groove on the face of the electrode.

The electrodes are insulated from the side bars of the frames by porcelain insulators resting on a wooden bar in the large machine and on fibre in the small machine. They are insulated from one another by the rubber packing rim surrounding the diaphragm and by nipples of pure rubber inserted in the water intake and gas offtake openings. When the device is assembled these nipples provide an insulating tube between the water intakes and gas offtakes.

To guard against grounding the apparatus through the small percentage of electrolyte which the gas carries with it from the cells, there is provided in the gas offtake system insulating pipe sections, each consisting of two sections of heavy glass tube clamped between iron flanges and so devised as to intercept and drain off through an insulating connection the moisture entrained in the gases. The gases leave these insulators substantially dry and free from electrolyte.

A number of features contribute toward a high electrical efficiency with this generator. The use of the patented nickel anode and iron cathode has been found to materially facilitate the electrolysis. The design of the generator is such as to retain within the apparatus most of the heat produced as a result of the ohmic resistance. This keeps the electrolyte and the electrodes at a comparatively high temperature, which adds to the efficiency of the electrolytic process. Furthermore, the solution of caustic potash has been found by experiment to utilize the current to best advantage.

The generator is filled, on starting the apparatus, with a solution of the electrolyte. As decomposition proceeds, water must be supplied to maintain the right level and the right density. On the front of the generator are two tanks or domes with glass water-level indicators which carry the solution. Pipes descend from these tanks to a water-feed manifold, which branches into two pipes connecting independently to the two water intakes to the cells and also into the two risers leading to two independent gas domes above. Into these domes the oxygen and hydrogen are separately discharged as generated, the gas offtakes opening through an inverted U below the fluid level. Next to these domes is a feed-water tank discharging distilled water through a float-controlled valve, as needed, to the solution tanks on the front of the generator.

This water-feed device creates an absolute balance of pressure throughout the generator. This eliminates circulation through the diaphragms due to unequal pressures on their two sides, removing any tendency to cause a mingling of gases through the diaphragm and relieving the diaphragm material from all mechanical stresses. The water-feed is absolutely proportioned to, and under the control of, the rate of gas generation.

This balanced pressure in both gas offtakes, due to the method of gas discharge, forbids any mixture of the gases and contributes to the balancing of pressures on the diaphragms.

The gases, escaping from the gas offtakes, rise through the fluid in the gas domes and pass out through discharge pipes at the top of the domes, thence downward to purgers on either side. These purgers are closed boxes of cast-iron filled with water to a certain level. The gases escape below the surface of the water, pass upward through it, and emerge thence through the supply lines to the gas holders. These purgers serve to catch any entrained fluid in the gas, cool the gas and act as a check to protect the pressure system of the generator from any undue pressure in the gas-holders.

A signal whistle is provided, which gives notice when the level of the solution in the generator falls below the prescribed limit. Sight-feed indicators on the solution tank and gas domes show the fluid levels and reveal the generation of the gases. Gage glasses connecting with the electrodes at intervals along the generator indicate the level of the electrolyte in the body of the apparatus.

Drain valves are provided to permit the emptying of the generator when required. These are of the lever operated gate type, designed to obviate any leakage or wear due to the presence of solid matter in the fluid.

CORROSIVE EFFECT OF ACETYLENE.—With the increasing use of acetylene gas the risks of its corrosive effect on pipes and metal containers should be better known. Tests have shown that moist acetylene, as generated, attacked zinc, lead, brass and nickel to a slight extent; iron was affected six to seven times as much; but copper suffered more than any other metal tested. Copper was quickly changed into a soft, porous black mass. Tin, aluminum, bronze, german silver and solder were practically unaffected. Thus it would appear that copper and brass or other copper alloys should not be used as piping for acetylene-gas supplies, and that iron should be well tinned rather than galvanized or nickel plated.—*American Machinist.*

MURRAY KEYOKE

A new design of hinged coupler yoke has recently been placed on the market by the Keyoke Railway Equipment Company, Chicago. It differs from the hinged coupler yoke previously made by that company in that it has a pinless interlocking hinge instead of the pin hinge. Its construction is clearly shown in

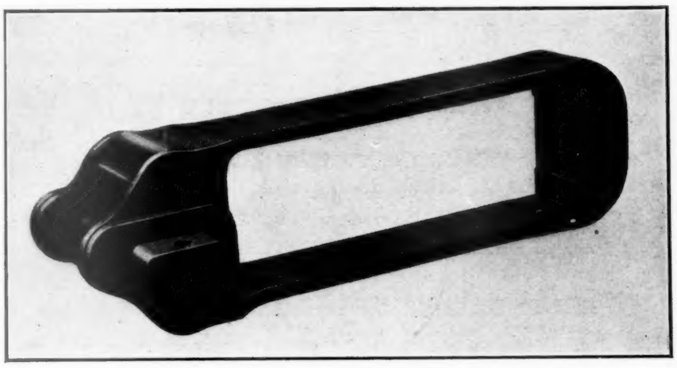


Fig. 1—Murray Keyoke

the illustrations. Fig. 1 shows the yoke in the closed position; Fig. 2 in the open position and Fig. 3 shows the yoke designed for use with a tandem spring gear. The yoke can be adapted for use with any design of draft gear. It is made of two open

Fig. 2—Keyoke Open

hearth thoroughly annealed steel castings, joined together at one end by the pinless interlocking hinge and at the other end by a standard 1⅛ in. by 5 in. coupler key.

The coupler end of the yoke is designed to fit accurately over

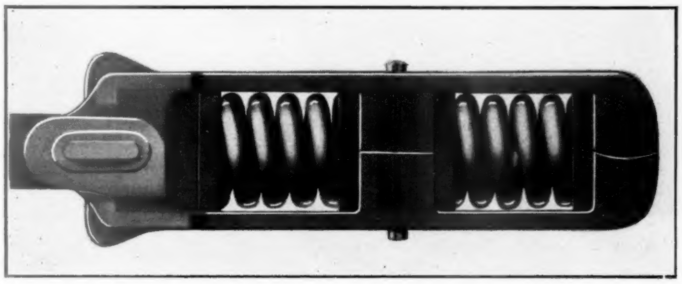


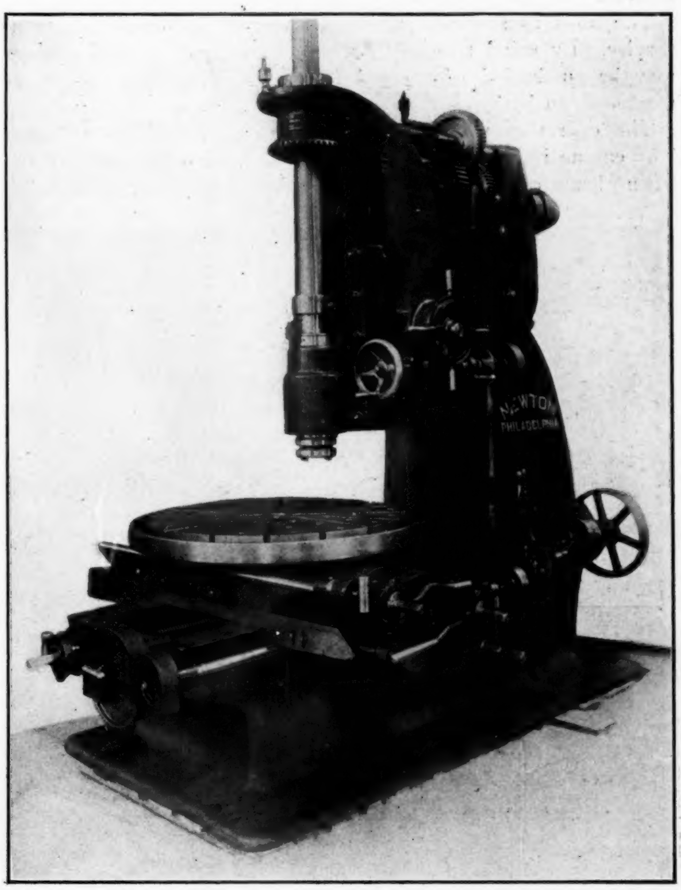
Fig. 3—Murray Keyoke for Tandem Spring Gear

the lugs on the end of the coupler, the pulling strains being taken on these lugs instead of on the coupler key, the latter serving principally to lock the yoke to the coupler. This feature is of special advantage in that the wings of the yoke will be subjected to but little stress, with the result that the key slots will not wear as readily and become elongated. This eliminates the lost motion and prevents the opportunity of failure at this point. This design brings the load directly to the upper and lower members of the yoke. Destruction tests have shown that a yoke of this type having a cross section of 1 in. by 5 in. will fail at a load of 474,000 lb. in these members, while wrought iron yokes made of 1¼ in. by 5 in. material and riveted to the coupler failed at a load of 245,000 lb., due to the shearing of the rivets. The gibs of this latter type of yoke, which are simply bent in to engage the lugs on the end of the coupler, break off at 254,000 lb. With the key connection and the hinged end it is possible to replace the coupler with but little trouble, no riveting or other blacksmith work being required.

VERTICAL MILLING MACHINE

The illustration shows a redesign of the extra heavy vertical milling machine built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. These machines have met with favor on account of the unusual flexibility of control, which permits a range of service from the successful use of end mills as small as ¾ in. in diameter, where the machines are used as die sinkers, to the heaviest of locomotive milling.

The design is especially adapted to alternating current motor drive, as, through the speed box gearing, changes are obtained without removal of gears. One of the essential features is the counterweighted spindle saddle with power vertical feeds and



Redesigned Newton Vertical Miller

fast power movement. The circular, in and out and cross-table motions are provided with reversing fast power traverse. These motions also have reversing power feeds and hand adjustments, all controlled from a localized position. The diameter of the circular table over the slots is 42 in. It has a cross feed of 30 in. and an in and out feed of 20 in. The spindle has a range of speeds from 8½ to 232 revolutions per minute.

The table is of the center clamp construction and is surrounded

by a pan which is drained through the centre into a reservoir. When the circular table is in the forward central position the machine will mill up to 38 in. outside diameter with cutters 8 in. in diameter. When the table is adjusted to the extreme of the cross slide, it will mill 48 in. in outside diameter.

UNWHEELING MALLET LOCOMOTIVES

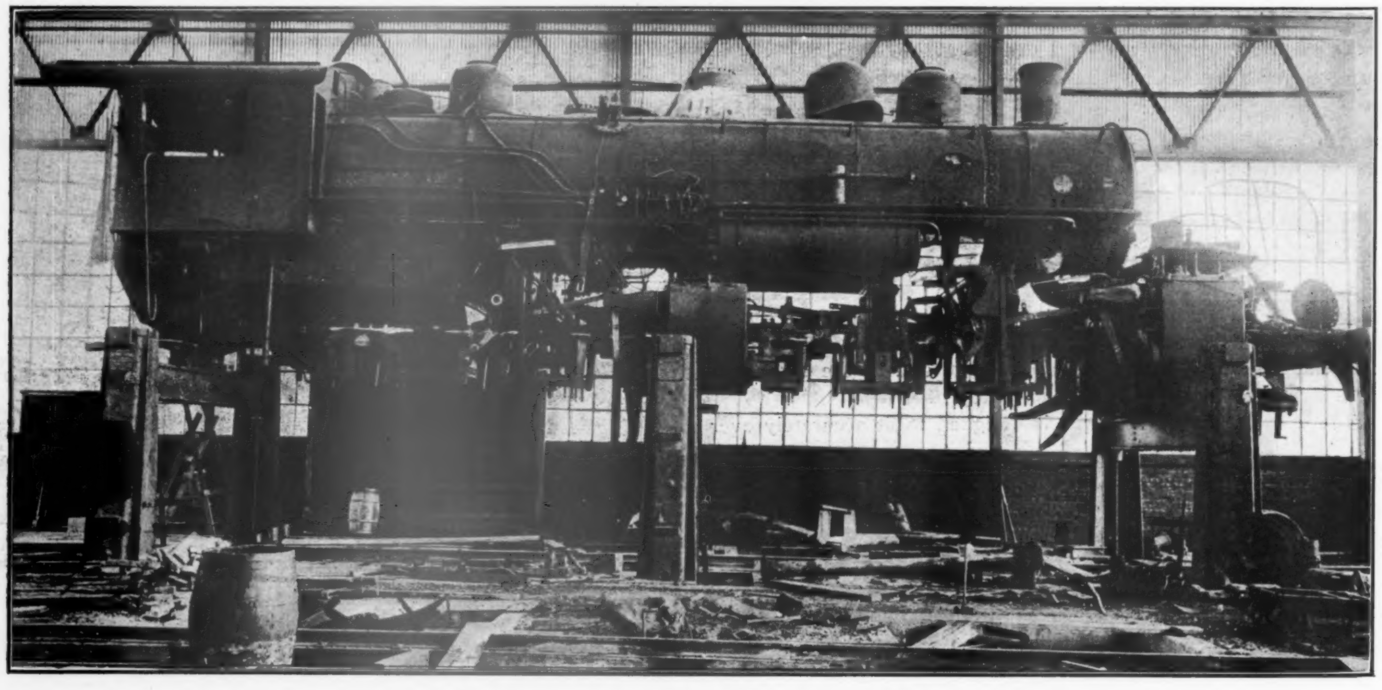
The illustration shows a screw-jack locomotive hoist which has been developed especially to solve the problem of unwheeling Mallet compound locomotives in shops provided with no overhead service or with cranes of insufficient capacity. This crane was installed in the shops of the Missouri, Oklahoma & Gulf at Muskogee, Oklahoma, by the Whiting Foundry Equipment Company, Harvey, Ill.

In many shops where overhead cranes are in use the rigging ordinarily used with road engines is not adapted to the loads and peculiar construction of the Mallet engine; for handling with overhead cranes in a transverse shop a crane with three 75-ton trolleys would be required, and the supporting steel-work in most shops would require considerable strengthening to support the load.

With this hoist all of the wheels can be removed at one time without disconnecting the low-pressure engine. Five to six hours on the pit is all that is required to remove the wheels and lower engine on the shop trucks. One of its advantages is that it can be installed in any building, the hoists standing on their own foundations and being entirely independent of the building.

The hoist as shown is adjustable to any length of engine in service. By using two pairs of jacks all types of road engines may be unwheeled with equal facility; drivers up to 84 in. in diameter can be handled.

The operation when handling Mallet engines is as follows: The engine is spotted with the high-pressure cylinders over the lifting beam of the center hoist, which is stationary. This hoist is thrown into gear and the beam brought up and proper blocking placed under the engine frame. The frames of high pressure and low pressure engines are clamped together, and the lifting beam under the low pressure cylinders is then brought into place and properly blocked; the beam under the rear end of the engine is finally brought into place and blocked. After all the beams are in proper position the motor is stopped, all hoists thrown into gear, the motor again started and the engine raised again until the wheels can be rolled out.



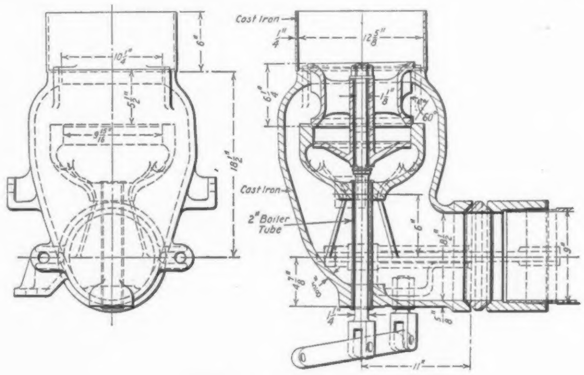
Whiting Locomotive Hoist Lifting a Mallet Engine

The lifting beams are dropped through slots in the track and have a section of track on top, thus allowing the engine to be run onto the hoist and spotted. Several slots in the track are arranged at proper distances for the two movable hoists, so that they may be adjusted to take any type of engine in service.

The lifting screws are carried on very heavy roller bearings between special hardened steel plates. The lifting speed is steady and slow.

WOODARD THROTTLE

An outside connected throttle valve has been developed and patented by the American Locomotive Company, New York, by the use of which a throttle standpipe of the usual type is dispensed with. This device is known as the Woodard Throttle and is shown in the drawing. This permits the location of the entire dome rigging close to one side of the dome, leaving room at one side to enter the dome without disturbing the throttle chamber and its connections.



The Woodard Throttle

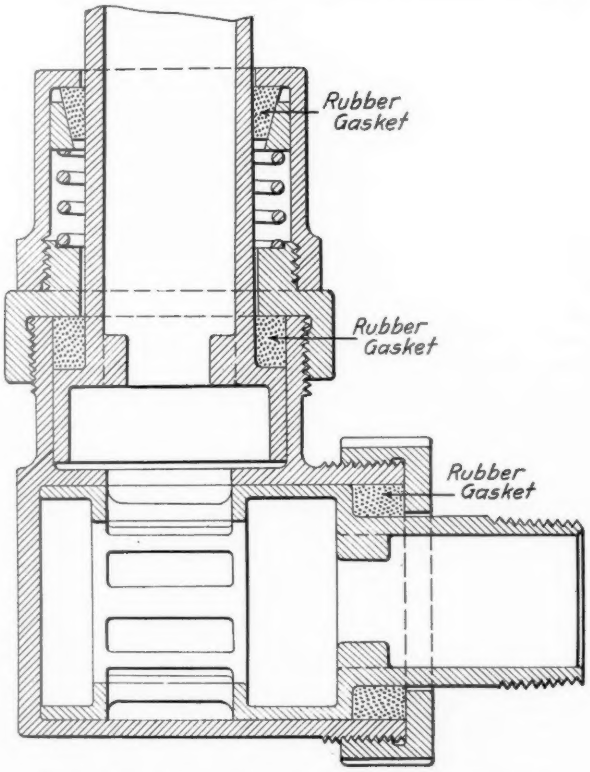
The lower valve seat is enclosed within the throttle chamber, being supported by ribs extending to the sides of the chamber. A cavity is thus formed within the chamber which is always open to boiler pressure. A passage leads from this cavity down through the chamber, through which passes the valve stem. This

passage is formed of a short piece of 2-in. boiler tube expanded into the casting at both ends, thus closing it from communication with the interior of the throttle chamber.

At the lower end of the throttle stem is a horizontal lever pivoted to the chamber casting, one end of which connects through a vertical rod with the inner arm of the operating shaft. This shaft extends through a stuffing box in the side of the dome of ordinary construction suitable for a rotating shaft. The throttle rod is connected to an arm on this shaft, outside of the dome, the outer end of the shaft being supported in an arm cast integral with the stuffing box.

FLEXIBLE PIPE CONNECTION

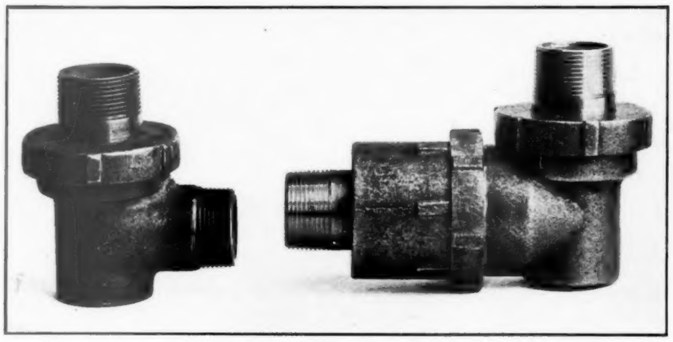
A new type of McLaughlin flexible conduit has recently been developed for use between the engine and tender. As shown in the photograph, this is made in both single and double types, the



Details of Construction of the Double Connection

construction of the latter being clearly indicated in the drawing. The single joint is similar to the horizontal part of the double joint.

The principal feature of the double joint is the use of two



Single and Double McLaughlin Flexible Connections

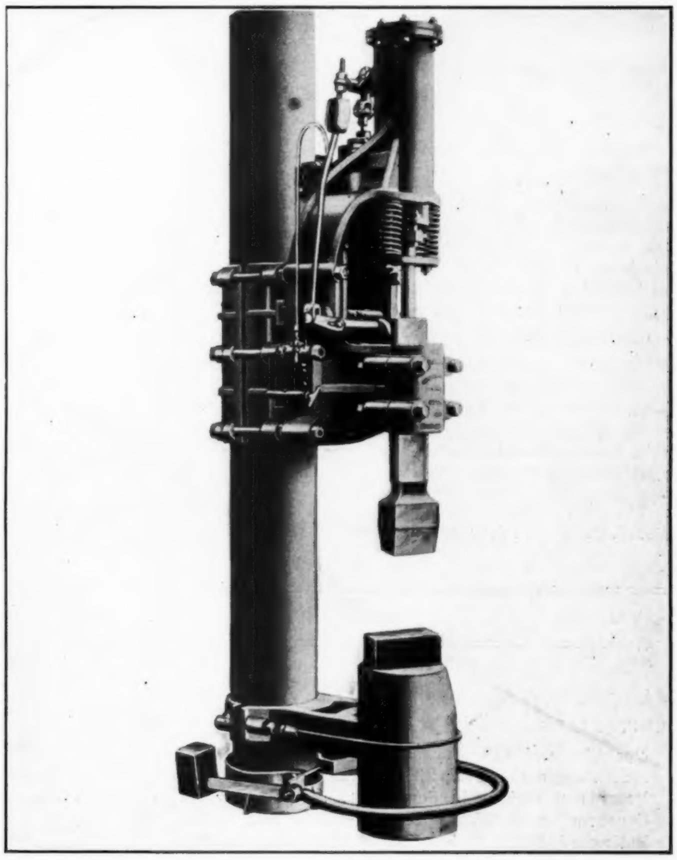
gaskets on the vertical branch. The device hangs near the center of gravity and is claimed to be less liable to leak than other similar devices. Should the main gasket become worn or break because of excessive wear from the weight of the conduit, the upper gasket will still prevent leakage. The lower or horizontal part of the joint is of ample proportions, thus reducing the friction through the joint to a minimum.

A consideration of importance in connection with this joint is the freedom of movement at all angles.

POST HAMMER

A light power hammer has been placed on the market by the Q M S Company, Chicago. The design is such that the hammer is easy to install wherever either steam or compressed air is obtainable.

The high price of tool steel makes it a valuable adjunct in any machine shop, where it may be used to draw down short pieces of tool steel, such as are usually scrapped, into small cut-



Post Hammer Driven by Steam or Compressed Air

ting tools for use in lathe tool holders. It is adaptable to all classes of light forging, as it may be easily handled by the blacksmith. The services of a helper are unnecessary.

The hammer is provided with a patent valve movement, which insures perfect control of the blow. If the treadle is brought down to the limit of its movement, the ram will strike a hard full blow, the same as a drop-hammer. When the treadle is pressed down part way the ram will give repeated blows, either hard or light, as may be required. The change from hard to light blows is made instantly and smoothly.

TRUING OILSTONES.—To true an oilstone, take a piece of soft pine board of any thickness, about 8 in. wide and 3 ft. or 4 ft. long. Lay it on a bench and fasten it with a handscrew or other clamp. Put on some clean, sharp sand screened about as fine as that used for plastering work. Use no water, and rub the stone back and forward over the board in sand. This will give a flat surface to the stone in a short time, which may be finished with fine sand or sandpaper.—*Mechanical World.*

Railway Mechanical Engineer

INCLUDING THE

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WE GUARANTEE, that of this issue 7,800 copies were printed; that of these 7,800 copies 6,800 were mailed to regular paid subscribers, 588 were provided for counter and news companies' sales, 97 were mailed to advertisers, exchanges and correspondents, and 315 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 7,800, an average of 7,800 copies a month.

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VOL. 90 JANUARY, 1916 NUMBER 1

CONTENTS

NEWS DEPARTMENT

The shops of the Missouri, Kansas & Texas at Sedalia, Mo., have been ordered to run seven days in the week; nine hours a day on week days and eight hours on Sunday.

The College of Engineering of the University of Illinois has received a Mogul type locomotive from the Illinois Central. It has 19-in. by 26-in. cylinders, and weighs with its tender 206,000 lb. It was taken from service and put through general repairs before delivery to the university. The locomotive will be used under the general direction of Prof. E. C. Schmidt for instructional work in the locomotive laboratory.

The "post office" or mail room in the general office building of the Baltimore & Ohio at Baltimore is now equipped with lock boxes, in the same style as a government post office; and each office in the building, having a key to the box assigned to it in the mail room, sends for its letters at any time of the day or night, as may be desired. This mail room at Baltimore handles about 35,000 pieces of mail every 24 hours, most of these being of course railroad service letters.

The executive committees representing the Brotherhood of Locomotive Engineers, the Brotherhood of Locomotive Firemen and Enginemen, the Brotherhood of Railway Trainmen and the Order of Railway Conductors at a meeting in Chicago on December 15, 16, 17, 18, 19 and 20, formulated demands to be presented to all the railroads in the country, providing for an eight-hour day or 12½ miles an hour speed basis in freight and yard service and time and one-half for overtime, with no change in the present schedules as to passenger service. The form of the proposed changes in the present agreements with the railroads expiring about April 30, 1916, are to be submitted to a referendum vote of the membership of the organizations.

The University of Illinois has maintained 10 research fellowships of $500 each for graduate work in the Engineering Experiment Station since 1907. Last spring four additional research

fellowships were created, making 14 in all. There will be five vacancies in these fellowships at the close of the current academic year and nominations for the places will be made from applications received by the director before February 1. Appointments are open to graduates of approved American and foreign universities and technical schools. If accepted, the student must remain two consecutive college years.

CAR AND LOCOMOTIVE ORDERS IN 1915

According to statistics compiled by the Railway Age Gazette, the railways and other purchasers of cars and locomotives in the United States, Canada and Mexico placed orders either with manufacturers or company shops during 1915 for 109,792 freight cars, 3,101 passenger cars and 1,612 locomotives. In addition to this the car and locomotive builders received orders from railways in foreign countries, notably the State Lines of Russia and France, for at least 18,222 freight cars and 850 locomotives. The domestic figures alone show an increase of about 40 per cent over 1914 when there were ordered for domestic use 80,264 freight cars, 2,002 passenger cars and 1,265 locomotives. The most remarkable thing about the year's business, however, is the fact that approximately one-half the domestic orders for the year were placed after the first of October.

The output for the year was exceedingly disappointing, there having been built only 74,112 freight cars, 1,949 passenger cars and 2,085 locomotives, the output for cars being the lowest since 1904 and that of locomotives the lowest since 1898. Of the 74,112 freight cars built, 14,128 were for export and of the 2,085 locomotives, 835 were for export.

The orders reported in the month of December were as follows:

	Locomotives	Freight Cars	Passenger Cars
Domestic	178	12,109	508
Foreign	11	......	...
Total	189	12,109	508

Among the important orders for locomotives were the following: Erie, 10 Pacific type locomotives, American Locomotive Company; Lehigh Valley, 10 Mikado locomotives, Baldwin Locomotive Works; and Canadian Government, 15 Consolidation and 10 Pacific type locomotives, Canadian Locomotive Company.

The freight car orders included the following: New York, New Haven & Hartford, 500 coal cars, Standard Steel Car Company; New York, Ontario & Western, 400 hopper cars, Cambria Steel Company, and 100 gondola cars, American Car & Foundry Company; Duluth & Iron Range, 500 ore cars, Standard Steel Car Company, 250 ore cars and 100 flat cars, American Car & Foundry Company; Duluth, Missabe & Northern, 1,000 ore cars, Western Steel Car & Foundry Company, and 200 general service cars, Pullman Company; Erie, 500 gondola cars, American Car & Foundry Company, and 1,000 hopper gondola cars, Pressed Steel Car Company; the Delaware, Lackawanna & Western, 1,000 box cars, American Car & Foundry Company, 300 gondola cars, Barney & Smith Car Company, and 200 gondola cars, Standard Steel Car Company; Pennsylvania Lines West, 1,000 gondola cars, American Car & Foundry Company, and 1,150 gondola cars, Haskell & Barker Car Company.

From the standpoint of passenger cars, the month of December was one of the best for the entire year. The orders included: Missouri, Kansas & Texas, 15 baggage, 4 dining and 2 postal cars, American Car & Foundry Company; Chicago, Burlington & Quincy, 8 dining, 9 passenger and baggage, 15 coaches, 15 chair, 2 coach and smoking and 5 postal cars, American Car & Foundry Company; Pennsylvania Lines West, 12 baggage and mail and 6 dining cars, Pullman Company, 22 coaches and 7 passenger baggage cars, Pressed Steel Car Company, and 24 baggage cars, Standard Steel Car Company; Pennsylvania Lines East, 21 baggage and 5 horse-express cars, American Car & Foundry Company, 6 coaches, Pressed Steel Car Company, 47 coaches, Harlan & Hollingsworth Corporation, and 28 baggage cars, J. E. Brill Company; and the New York Central Lines, 15 coaches for the Cleveland, Cincinnati, Chicago & St. Louis, Barney & Smith Car Company, 25 coaches for the Boston & Albany, and 20 for the New York Central, Osgood Bradley Car Company, 15 coaches for the Michigan Central, American Car & Foundry Company, and 30 coaches for the New York Central, American Car & Foundry Company.

EXTENSION OF TIME TO COMPLY WITH SAFETY APPLIANCE ACTS

The Interstate Commerce Commission has granted a further extension of 12 months from July 1, 1916, to the time within which the carriers must make their freight train cars conform to the safety appliance acts. By an order of the commission dated March 13, 1911, issued in conformance with an act of Congress approved April 14, 1910, the carriers were allowed an extension of time of five years from July 1, 1911. By the present order the former order is extended one year.

The commission's order of March 13, 1911, was as follows:

(*a*) Carriers are not required to change the brakes from right to left side on steel or steel underframe cars with platform end sills, or to change the end ladders on such cars, except when such appliances are renewed, at which time they must be made to comply with the standards prescribed in said order of March 13, 1911.

(*b*) Carriers are granted an extension of five years from July 1, 1911, to change the location of brakes on all cars other than those designated in paragraph (*a*) to comply with the standards prescribed in said order.

(*c*) Carriers are granted an extension of five years from July 1, 1911, to comply with the standards prescribed in said order in respect of all brake specifications contained therein, other than those designated in paragraph (*a*) and (*b*), on cars of all classes.

(*d*) Carriers are not required to make changes to secure additional end-ladder clearance on cars that have 10 or more inches end-ladder clearance, within 30 inches of side of car, until car is shopped for work amounting to practically rebuilding body of car, at which time they must be made to comply with the standards prescribed in said order.

(*e*) Carriers are granted an extension of five years from July 1, 1911, to change cars having less than 10 inches end-ladder clearance, within 30 inches of side of car, to comply with the standards prescribed in said order.

(*f*) Carriers are granted an extension of five years from July 1, 1911, to change and apply all other appliances on freight cars to comply with the standards prescribed in said order, except that when a car is shopped for work amounting to practically rebuilding body of car, it must then be equipped according to the standards prescribed in said order in respect to handholds, running boards, ladders, sill steps, and brake staffs: *Provided*, That the extension of time herein granted is not to be construed as relieving carriers from complying with the provisions of section 4 of the act of March 2, 1893, as amended April 1, 1896, and March 2, 1903.

(*g*) Carriers are not required to change the location of handholds (except end handholds under end sills), ladders, sill steps, brake wheels, and brake staffs on freight-train cars where the appliances are within 3 inches of the required location, except that when cars undergo regular repairs they must then be made to comply with the standards prescribed in said order.

The order applies only to paragraphs (b), (c), (d) and (f). As to the matters in the other paragraphs the carriers have already been granted an indefinite extension of time.

MEETINGS AND CONVENTIONS

Master Boiler Makers' Association.—The tenth annual convention of the Master Boiler Makers' Association will be held at the Hollenden Hotel, Cleveland, Ohio, May 23 to 26, inclusive, 1916.

General Foremen's Association.—The twelfth annual convention of the International Railway General Foremen's Association will be held at the Hotel Sherman, Chicago, Ill., August 29, 30, 31 and September 1, 1916.

The American Society of Mechanical Engineers.—The following is the list of the newly elected officers of the American Society of Mechanical Engineers for the coming year: D. S. Jacobus, president; W. B. Jackson, J. Sellers Bancroft and Julian Kennedy, vice-presidents; J. H. Barr, J. A. Stevens and H. deB. Parsons, managers, and W. H. Wiley, treasurer.

Western Railway Club.—At the December meeting of the Western Railway Club it was announced that hereafter the regular monthly meeting will be held in the Grand Pacific hotel, Chicago, the third Tuesday evening in every month, except June, July and August. Arrangements have also been made for those who remain in town for the meeting to have their dinner at the hotel in a special room that will be reserved for the club mem-

bers. This will present a good opportunity for a general get-together meeting before the paper of the evening is presented. It was also announced that a light luncheon will be served after the meeting, and in order not to make the meetings unduly late the speaker will be introduced promptly at 8 o'clock and the discussion will be closed at 9:30.

Atlantic City Exhibits.—The Railway Supply Manufacturers' Association has sent out an official circular relating to the exhibits at Atlantic City during the Master Car Builders' and American Railway Master Mechanics' conventions, which will be held June 14-21, 1916, in which it designates Friday, February 18, as the time at which assignments of space will be made. So many inquiries about space were received because of a preliminary circular which was sent out about a month ago that it is advisable for those who have exhibited in previous years and who expect to exhibit next June, to make immediate application to J. D. Conway, secretary-treasurer, Oliver Building, Pittsburgh, Pa. A number of improvements are to be made on the Million Dollar Pier, which will add to the exhibit space and also contribute to the convenience of the exhibitors. Aquarium Court will be rearranged, the spaces on the south side being extended 3 ft. out into the isle and the isleways on both sides being roofed over. The decorations in the main building at the entrance to the pier will be entirely new and even more attractively than in former years. No dividing rails will be permitted in Machinery Hall and its extension and the floors will be thoroughly cleaned and oiled. New matting will be used throughout this building as well as in all the other sections of the exhibit space. More or less trouble has been experienced in the past because of insufficient power. Arrangements have been made to insure an ample supply for the coming conventions. Applications for space will be considered in the order of their receipt and should be forwarded to Secretary Conway at once.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass.
AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—W. E. Jones, C. & N. W., 3814 Fulton St., Chicago.
AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.
AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago.
AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.
ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.
CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago. Second Monday in month, except July and August, Lytton Building, Chicago.
CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—W. R. McMunn, New York Central, Albany, N. Y.
INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, 922 McCormick Building, Chicago.
INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, August 29-31, 1916, Hotel Sherman, Chicago.
INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio.
MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.
MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.
MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass.
NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings monthly.
RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.
TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., East Buffalo, N. Y.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

R. E. ANDERSON has been appointed air brake instructor of the Chesapeake & Ohio, with headquarters at Richmond, Va.

P. CONNIFF, superintendent of shops of the Baltimore & Ohio, at Mount Clare, Baltimore, Md., has been appointed special inspector of the mechanical department.

H. C. MAY, superintendent of motive power of the Chicago, Indianapolis & Louisville, has been appointed to the same position on the Lehigh Valley, with office at South Bethlehem, Pa succeeding F. N. Hibbits, resigned.

J. J. MCNEILL, road foreman of engines for the Erie at Cleveland, Ohio, has been appointed supervisor of locomotive operation, with office at Youngstown, Ohio, succeeding D. J. Madden, promoted.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

JOSEPH BLUETGE has been appointed road foreman of engines for the Erie at Cleveland, Ohio, succeeding J. J. McNeill, promoted.

B. CORBETT has been appointed master mechanic of the Missouri, Kansas & Texas at Smithville, Tex., succeeding J. R. Greiner, resigned.

H. A. ENGLISH has been appointed master mechanic of the Canadian Northern, central division, with office at Winnipeg, Man., succeeding G. H. Hedge, promoted.

G. H. HEDGE, master mechanic of the central division of the Canadian Northern, has been appointed general master mechanic of western lines, with office at Winnipeg, Man.

G. H. NOWELL, formerly locomotive foreman of the Canadian Pacific at Cranbrook, B. C., has been appointed district master mechanic at Nelson, B. C.

J. W. TENNEY has been appointed road foreman of equipment, Chicago, Rock Island & Pacific, with headquarters at Trenton, Mo., succeeding M. J. McDonald, promoted.

F. J. YONKERS has been appointed road foreman of equipment for the Colorado division of the Chicago, Rock Island & Pacific, with headquarters at Goodland, Kan.

CAR DEPARTMENT

T. C. CHOWN has been appointed acting assistant works manager at the Angus car shops of the Canadian Pacific, Montreal, during the absence of L. C. Ord.

A. GREY, assistant car foreman of the Canadian Northern at Winnipeg, has been appointed car foreman at Lucerne, B. C.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Jan. 11			James Powell	St. Lambert, Que.
Central	Jan. 14	Yard Operation Modern Roundhouse Methods and Facilities	J. R. Hamilton J. H. De Salis	Harry D. Vought	95 Liberty Street, New York
New England	Jan. 11	Physicial Valuation of Railroads	F. C. Shepherd	Wm. Cade, Jr.	683 Atlantic Avenue, Boston, Mass.
New York	Jan. 21	Modern Brake Apparatus	Dr. S. W. Dudley	Harry D. Vought	95 Liberty Street, New York
Pittsburgh	Jan. 28	Fuel Economy	H. C. Woodbridge	J. B. Anderson	207 Penn Station, Pittsburgh, Pa.
Richmond	Jan. 10	Transportation in Alaska	W. R. Crane	F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	Jan. 14	Useful Personality	V. L. Price	B. W. Frauenthal	Union Station, St. Louis, Mo.
South'n & S'w'rn	Jan. 18			A. J. Merrill	Box 1205, Atlanta, Ga.
Western	Jan. 18			Jos. W. Taylor	1112 Karpen Bldg., Chicago, Ill.
Western Canada	Jan. 10			Louis Kon	Box 1707, Winnipeg, Man.

J. E. HUGHES, car foreman of the Canadian Pacific at Union Station, Toronto, has been made car foreman in charge of general repairs at North Bay, Ont., succeeding J. Cowley, who is on extended leave of absence.

J. JOLLY has been appointed car foreman of the Canadian Pacific at Lambton, Ont., succeeding J. Bannon, transferred.

W. F. MILLER, heretofore car foreman of the Canadian Northern at Parry Sound, Ont., has been appointed car foreman at Toronto, Ont.

L. C. ORD, assistant works manager, Angus car shops, Montreal, Que., of the Canadian Pacific, has been granted leave of absence to enter active service, as lieutenant in No. 1 overseas battery of the siege artillery, Canadian expeditionary force. Mr. Ord has left for the front.

SHOP AND ENGINE HOUSE

O. S. BEYER, JR., general foreman of the Horton, Kan., shops of the Chicago, Rock Island & Pacific, has been appointed first assistant in the engineering experiment station in the department of railway engineering of the University of Illinois.

C. BOARDMAN, foreman in the Winnipeg shops of the Canadian Pacific, has been appointed locomotive foreman at Red Deer, Alta., succeeding C. A. Little, transferred.

E. J. BRENNAN, formerly division master mechanic of the Buffalo, Rochester & Pittsburgh at Du Bois, Pa., has been appointed superintendent of shops of the Baltimore & Ohio, at Glenwood, Pittsburgh, Pa.

G. CANFIELD has been appointed locomotive foreman of the Canadian Northern at Jellicoe, Ont.

M. A. CARDELL has been appointed locomotive foreman of the Canadian Northern at Tollerton, Alta.

P. CARLISLE has been appointed roundhouse foreman of the Intercolonial at Moncton, N. B.

F. CARROLL has been appointed foreman blacksmith of the Intercolonial at Moncton, N. B., succeeding A. Stockall, retired.

L. FINEGAN, superintendent of shops of the Baltimore & Ohio at Glenwood, Pittsburgh, Pa., has been appointed superintendent of shops at Mount Clare, Baltimore, Md., succeeding P. Conniff, assigned to other duties.

A. FOURNIER has been appointed locomotive foreman of the Canadian Northern at Sudbury, Ont.

O. C. GRANT has been appointed locomotive foreman of the Canadian Northern at Parry Sound, Ont.

L. B. LARSON, formerly locomotive foreman for the Chicago & Alton at Kansas City, Mo., has been appointed erecting shop foreman in the shops of the Oregon Short Line at Pocatello, Idaho.

H. N. LUKES, assistant air brake inspector of the Canadian Northern, has been appointed locomotive foreman at Blue River, B. C.

A. MALLINSON has been appointed locomotive foreman of the Canadian Northern at Capreol, Ont.

E. J. MURPHY, assistant locomotive foreman of the Canadian Pacific at Lambton, Ont., has been made locomotive foreman, succeeding F. Ronaldson, promoted.

I. C. NEWMARCH, general foreman in the Collinwood, Ohio, locomotive shops, of the New York Central, has been appointed superintendent of shops at Collinwood, succeeding R. H. Montgomery, deceased.

T. RYAN has been appointed roundhouse foreman of the Intercolonial at Riviere du Loup, Que., succeeding V. Saindon, who has been assigned to other duties.

J. H. THOMPSON has been appointed locomotive foreman of the Canadian Northern at Ottawa, Ont.

PURCHASING AND STOREKEEPING

E. J. ALEXANDER, second assistant to the receiver, has been appointed fuel agent of the Chicago & Eastern Illinois, succeeding C. G. Hall, resigned to become secretary of the Northern Indiana Coal Trade Bureau.

C. L. BANKSON has been apointed assistant purchasing agent of the Great Northern, with office at Seattle, Wash., succeeding A. Watson.

A. S. BROWN has been appointed storekeeper of the Salt Lake & Ogden, with office at Salt Lake City, Utah, succeeding W. H. Bliss, resigned.

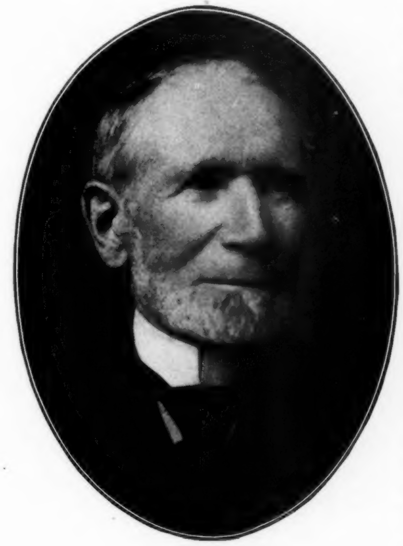
E. HUMPHRYS, fuel agent of the Canadian Pacific, has been appointed storekeeper of the Manitoba division at Winnipeg, Man., and the duties of fuel agent are incorporated with those of the latter position.

OBITUARY

WILLIAM C. HAYES, superintendent of locomotive operation of the Erie at New York, died on December 25 at his home in New York.

THOMAS J. HENNESSEY, formerly division master mechanic of the Michigan Central at Bay City, Mich., died on December 4, 1915. Mr. Hennessey was born at London, Ontario, on January 1, 1845. He began his railroad career as a fireman on the Michigan Central in 1872 and became an engineer in 1874. In 1889 he was made traveling engineer, which position he occupied till he was appointed division master mechanic at Detroit in 1893. Mr. Hennessey successively served in a similar capacity at Jackson and Bay City, Michigan, being transferred to the latter point early in 1902. Here he remained until retired from the service, on reaching the age limit, in February, 1915.

JOHN KIRBY, general master car builder of the Lake Shore & Michigan Southern from October, 1870, to October, 1892, died on December 8, at Adrian, Mich. Mr. Kirby was born in October, 1823, in Oxfordshire, England, and was educated in the common schools. He began railway work in May, 1848, and until 1854 was engaged in repairing cars on the Syracuse & Utica, which is now a part of the New York Central. He was then engaged in repairing and building cars on the Michigan Southern at Adrian, Mich. From September, 1856, to September, 1858, he was foreman of shops at Adrian; then to October, 1870, was master car builder of the Michigan Southern & Northern Indiana, which subsequently became a part of the Lake Shore & Michigan Southern. In October, 1870, he was appointed general master car builder of the Lake Shore & Michigan Southern, remaining in that position until October, 1892. Mr. Kirby was president of the Master Car Builders' Association in 1891 and 1892, and from 1900 to 1909 was treasurer of the same association.


J. Kirby

SUPPLY TRADE NEWS

Wilfred R. Dean, vice-president of the Dean Brothers Pump works, Indianapolis, Ind., died recently, after a prolonged illness.

Frank R. Peters, formerly with J. Stone & Co., London, has joined the electrical staff of the Franklin Railway Supply Company.

S. K. Smith, treasurer of the Harlan & Hollingsworth Corporation, has also been elected vice-president, succeeding Persifor Frazer.

The American Steel Foundries have taken over the Elliott brake beam safety hanger hitherto handled by the Elliott Company, of Philadelphia.

H. E. Walker, for several years New York representative of the S. K. F. Ball Bearing Company, Hartford, Conn., has severed his connection with that company.

The Burdett Oxygen Company completed a new plant at Ft. Worth, Tex., on December 15. This is the ninth plant to be erected by the company in various industrial centers of the country.

George R. Henderson, consulting engineer of the Baldwin Locomotive Works, has resigned from that position and opened an independent office as consulting engineer at 1321 Walnut street, Philadelphia, Pa.

Frank Howard Bailie, assistant manager of sales of the H. K. Porter Company, Pittsburgh, Pa., died after a brief illness from pneumonia on Tuesday, December 14. Mr. Bailie had been associated with the company for 27 years.

B. H. Forsyth, who for the past three years has been connected with the sales department of the Hale & Kilburn Company, with office at Chicago, and formerly sales manager of the Ford & Johnson Company, resigned, effective January 1.

Flint & Chester, Inc., New York, have taken the exclusive sales agency for the United States and Canada for the National Graphite Lubricator Company, Scranton, Pa. The lubricators made by the latter have been adopted by 11 railroads and installed on 40 others.

James Mapes Dodge, chairman of the board of directors of the Link-Belt Company, Chicago, Ill., died at his home in Philadelphia, September 4. Mr. Dodge was born June 30, 1852, at Waverly, N. J. He studied three years at Cornell University and then took a special one-year course in chemistry at Rutgers. After spending a short time at the Morgan Iron Works in New York, he entered the shops of James Roach, the shipbuilder, at Chester, Pa., where, during a three years' stay, he was successively journeyman, foreman and superintendent of erection. About 1880 he became acquainted with William D. Ewart, the inventor of the Ewart link-belting, and soon after joined him and his associates in the development of the chain business, which at that time had not attained a very great importance. He later entered into a partnership with Edward H. Burr, under the name of Burr & Dodge, who represented in Philadelphia the Ewart Manufacturing Company of Indianapolis, then manufacturing the Ewart detachable link-belt. Out of this partnership grew the Link-Belt Engineering Company, organized in 1888. In 1889 Mr. Dodge brought out the Dodge system of storing anthracite coal in large conical piles and reloading it by machinery. For this invention he received in 1907 the Elliott Cresson gold medal from the Franklin Institute. In 1892 Mr. Dodge was elected president of the Link-Belt Engineering Company and the Dodge Coal Storage Company (later called the J. M. Dodge Company). He became chairman of the board of directors of the Link-Belt Company when it was organized in 1906 through the merger of the allied companies—the Link-Belt Engineering Company, Philadelphia; the Link-Belt Machinery Company, Chicago, and the Ewart Manufacturing Company, Indianapolis, at which time Charles Piez became president of the Link-Belt Company. Mr. Dodge has been a very successful inventor. He took out over 100 patents, among them, of course, being many relating to the construction and manufacture of silent chain.

C. W. Cross, from 1906 to 1914 superintendent of apprentices of the New York Central Lines, has been elected vice-president of the Equipment Improvement Company, with office at 30 Church street, New York. Mr. Cross started his railroad career as a machinist apprentice on the Cincinnati, Hamilton & Dayton at Lima, Ohio. From 1880 to 1890 he was, respectively, a machinist, draftsman, foreman and assistant master mechanic in the shops of the Pennsylvania Lines at Fort Wayne, Ind. In 1890 he went to the Lake Shore & Michigan Southern as master mechanic at Elkhart, Ind., and became superintendent of apprentices for the New York Central Lines, with headquarters at New York, when that railroad revised and centralized its apprenticeship department in 1900. Mr. Cross has been a representative for the Equipment Improvement Company since July, 1914. He took up his new duties as vice-president on December 15.

C. W. Cross

Andrew J. Farley, vice-president of the Camel Company, and for many years secretary of the Chicago Railway Equipment Company, died on December 13, 1915, at the Hyde Park hotel, Chicago, Ill. Mr. Farley was born at Schuylerville, N. Y., in 1847, and spent his early life in Troy, N. Y., where he was, at one time, engaged in the retail business. His advent in the railway supply business was with the old Dunham Manufacturing Company. When he left this company he became connected with The National Brake Beam Company, now the Chicago Railway Equipment Company, with which he spent most of his business career. About five years ago he retired from active business and has lived most of each year at his summer place at Wheaton, Ill., spending the winters in Chicago and California. He was one of the organizers of the Camel Company, and at the time of his death was vice-president. He is survived by his wife and one daughter, Mrs. James M. Hopkins.

A. J. Farley

The Youngstown Steel Car Company was recently organized at Youngstown, Ohio, to assume the business of the Youngstown Car & Manufacturing Company, designers and builders of in-

dustrial equipment. J. E. Tesseyman, formerly of the Ralston Steel Car Company, Columbus, Ohio, has assumed the duties of general manager, and plans are being formulated for enlarging the company's output. The company is entering the field of repairing steel cars, and is at present making prompt deliveries on pressed steel parts.

James Brown Rider has been elected vice-president and general manager of the Pressed Steel Car Company and the Western Steel Car & Foundry Company. Mr. Rider entered the service of the Pennsylvania Railroad in 1895, and remained with it until 1899, acting successively as messenger boy, shop order clerk, invoice clerk and stenographer. In 1899 he became connected with the Pressed Steel Car Company as stenographer and clerk to the general manager, being advanced to the position of assistant to the vice-president in July, 1905. He was appointed general manager in July, 1909, and made a member of the board of directors in Jan., 1913. He was appointed general manager of the Western Steel Car & Foundry Company August, 1913. He is now elected a vice-president of the Pressed Steel Car Company and Western Steel Car & Foundry Company, with headquarters in Pittsburgh, Pa., and will also continue to perform the duties of general manager in charge of operation. His title is vice-president and general manager of both companies.

J. B. Rider

N. S. Reeder, vice-president of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, graduated from Cornell University with the degree of mechanical engineer in 1896. He then served as a special apprentice on the Pennsylvania Lines West of Pittsburgh, and in 1899 was employed by the Pittsburgh Coal Company as superintendent of the Montour and Moon Run Railroads. In 1902 he entered the service of the Pressed Steel Car Company as a mechanical engineer connected with the New York office, but in 1904 he went to Montreal as assistant general manager of the Canada Car Company. In 1906 he was made general manager, and in 1908 became second vice-president of the Canadian Car & Foundry Company. He returned to the States in 1909 as vice-president of the Western Steel Car & Foundry Company, and in 1910 was made second vice-president of the Pressed Steel Car Company in Chicago. He is now transferred to the company's New York office, effective December 1.

N. S. Reeder

J. F. McEnulty has been elected second vice-president of the Pressed Steel Car Company and the Western Steel Car & Foundry Company. Mr. McEnulty entered the employ of the Pressed Steel Car Company in 1899, and has been its general sales manager since May, 1912. He was first an inspector at Pittsburgh, later being promoted to the positions of chief inspector, general chief inspector and engineer of construction. He was transferred to the sales department in New York in 1904, and in 1907 was made general superintendent of the Hegewisch Works of the Western Steel Car & Foundry Company. In 1909 he was promoted to the position of general manager, and in May, 1912, returned to New York as general sales manager of both the Pressed Steel Car Company and Western Steel Car & Foundry Company.

J. F. McEnulty

C. E. Postlethwaite, who since December 1 has been general sales manager of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, with headquarters in New York, was until that date manager of sales for the central district at Pittsburgh, Pa. He was born in Mount Union, Huntington county, Pa., and after graduating from the Altoona high school in 1883 entered the service of the Pennsylvania Railroad, where he remained until 1890, acting successively as rodman on an engineer corps, telegraph operator and Pennsylvania Railroad division car clerk. For the following seven years he was connected with the Norfolk & Western as chief clerk to the general superintendent at Roanoke, and later as assistant to the general agent at Norfolk. He became connected with the Schoen Pressed Steel Car Company in October, 1897, shortly after the first steel freight cars were built, and remained with the company when it was merged into the Pressed Steel Car Company. Mr. Postlethwaite entered the sales department of the company in February, 1902.

C. E. Postlethwaite

A. F. Huston, president of the Lukens Iron & Steel Company, Coatesville, Pa., has recently announced that his company has placed an order for a plate mill which will be able to roll a plate 200 to 204 in. wide and which will be the largest plate mill in existence in the world at the present time.

Henry C. Kloos, of the electrical staff of the Pullman Company, has accepted a position with the Franklin Railway Supply Company, New York. This company is now engaging in the manufacture and sale of car lighting equipment, and is placing upon the American market the "Stone" system of car lighting,

hitherto manufactured in England and extensively employed abroad.

Henry Phipps Hoffstot has been appointed to the position of assistant manager of sales, central district, of the Pressed Steel Car Company, with headquarters at Pittsburgh, Pa. Mr. Hoffstot has been in the service of the company since 1910. He graduated from Harvard College in 1909, and in the same year entered the employ of the Canadian Car & Foundry Company at Montreal and Amherst, N. S. The following year he was appointed assistant to the general manager of the Pressed Steel Car Company, and on December 1 entered the sales department of the company as assistant manager of sales, central district, with headquarters at Pittsburgh, as above noted.


H. P. Hoffstot

Edward F. Carry, Chicago, has been elected president of the reorganized Haskell & Barker Car Company, of Michigan City, Ind. Mr. Carry was born in Fort Wayne, Ind., on May 16, 1867, and was educated in the public schools of that city. He began his business career with the Wells & French Car Company, Chicago, and was secretary of this company at the time of its consolidation with the American Car & Foundry Company. He has served the latter company for 28 years as district manager, third vice-president, second vice-president and later as first vice-president and general manager. Since 1903 he has been a director and member of the executive committee of the company. Mr. Carry's election as president of the Haskell & Barker Car Company was effective on January 1; he will take office on January 10, upon the completion of legal details. The following directors of the Haskell & Barker Car Company have been elected: Frank A. Vanderlip, president of the National City Bank; W. E. Corey, president of the Midvale Steel & Ordnance Corporation; Ambrose Monell, president of the International Nickel Company; Joseph W. Harriman, president of the Harriman National Bank; John Morron, president of the Atlas Portland Cement Company; E. S. Webster, Stone & Webster; A. O. Choate, Potter, Choate & Prentice; and Edward F. Carry. Two additional directors will be chosen later on. Mr. Carry has a large circle of friends among railway officers throughout the country. His home is in Chicago, with summer residence at Lake Forest, Ill.


E. F. Carry

W. L. Conwell, vice-president and treasurer of the Transportation Utilities Company, New York, has been appointed assistant to the president of the Safety Car Heating & Lighting Company, effective January 1. Mr. Conwell has been in the service of the Transportation Utilities Company since 1911. He was born at Covington, Ky., January 25, 1877. He received his education in the public schools of Philadelphia and at the University of Pennsylvania, from which he graduated in 1898 with the degree of electrical engineer. He then passed the examinations for first assistant engineer for the United States Navy, but received no appointment because of the cessation of hostilities. He was employed in contracting work as a time-keeper for the Tennis Construction Company, Philadelphia, becoming later chief engineer and secretary of the company. In 1901 he resigned to become city salesman of the Westinghouse Electric & Manufacturing Company in New York. He was later placed in charge of the isolated plant department of the company, and for five years, ending in 1911, was engaged in railway work. He then became vice-president of the Transportation Utilities Company.


W. L. Conwell

Paul M. Lincoln, for over 23 years connected with the operating and engineering activities of the Westinghouse companies, on January 1 became associated with the sales department of the Westinghouse Electric & Manufacturing Companyy, with the title of commercial engineer. Mr. Lincoln, shortly after his graduation from Ohio State University in 1892, entered the employ of the Short Electric Company in Cleveland. He then went to the Westinghouse Electric & Manufacturing Company, and was engaged in the testing-room, and in general engineering work. When the plant of the Niagara Falls Power Company was opened he became its electrical superintendent, and as such had much to do with the first transmission line to Buffalo. In 1902 he returned to the Westinghouse Company, specializing on the general engineering of power stations and transmission lines. He was for several years in charge of the power engineering department, but was transferred to the engineering department when that was organized. Mr. Lincoln is well known in engineering circles through his active work in the American Institute of Electrical Engineers, of which at one time he was president. He is a well-known writer on technical subjects and has also been identified with educational work for some time, filling the chair of professor of electrical engineering at the University of Pittsburgh.


P. M. Lincoln